Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

20-SGD-0008

OCT 3 1 2019

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Mr. Craig E. Cameron, Program Manager
Office of Environmental Cleanup
Site Cleanup Unit 4
U.S. Environmental Protection Agency
825 Jadwin Avenue, Suite 210
Richland, Washington 99352

Addressees:

SAMPLING AND ANALYSIS PLAN FOR CHARACTERIZATION OF GROUNDWATER MONITORING WELLS 299-E27-27, 299-E27-40 AND 699-43-43B, DOE/RL-2019-31, DRAFT A

This letter transmits the Sampling and Analysis Plan for Characterization of Groundwater Monitoring Wells 299-E27-27, 299-E27-40 and 699-43-43B, DOE/RL-2019-31, Draft A to the Washington State Department of Ecology and U.S. Environmental Protection Agency for review and comment.

The sampling and analysis plan (SAP) describes characterization efforts planned during the drilling and construction of three Hanford Federal Facility Agreement and Consent Order Milestone M-024-70-T01 groundwater monitoring wells in the 200-BP-5 and 200-PO-1 Operable Units.

If you have any questions, please contact me, or your staff may contact, Mike Cline, of my staff, on (509) 376-6070.

Sincerely,

William F. Hamel, Assistant Manager
for the River and Plateau

SGD:JPH

Attachment

cc: See page 2

cc w/attach:
J. Bell, NPT
R. Buck, Wanapum
L. Contreras, YN
D. R. Einan, EPA
M. Johnson, CTUIR
S. Leckband, HAB
N. M. Menard, Ecology
K. Niles, ODOE
S. N. Schleif, Ecology
Administrative Record (M-024-70-T01,
200-BP-5, 200-PO-1)
Environmental Portal

cc w/o attach:
S. G. Austin, CHPRC
S. L. Brasher, MSA
S. W. Davis, MSA
M. H. Doornbos, CHPRC
W. R. Faught, CHPRC
L. K. O'Mara, CHPRC

DOE/RL-2019-31
Draft A

SAMPLING AND ANALYSIS PLAN FOR CHARACTERIZATION OF GROUNDWATER MONITORING WELLS 299-E27-27, 299-E27-40 AND 699-43-43B

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2019-31
Draft A

SAMPLING AND ANALYSIS PLAN FOR CHARACTERIZATION OF GROUNDWATER MONITORING WELLS 299-E27-27, 299-E27-40 AND 699-43-43B

Date Published
September 2019

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Lynn M. Ayers at 9:35 am, Oct 03, 2019

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Contents

1 Introduction 1-1

1.1 Project Scope and Objectives 1-4
1.2 Background and Setting 1-4
1.2.1 Geology 1-5
1.2.2 216-B-3 Pond Waste Site Description and History 1-8
1.2.3 Decommissioned Groundwater Monitoring Well 699-43-44 at 216-B-3 Pond 1-8
1.2.4 WMA C Waste Site Description and History 1-10
1.2.5 Decommissioned Groundwater Monitoring Well 299-E27-4 at WMA C 1-10
1.2.6 Groundwater Monitoring Well 299-E27-27 1-12
1.2.7 Stainless Steel Wells and Corrosion 1-12
1.2.8 CERCLA Interim Actions/Cumulative Impact Evaluation 1-13
1.2.9 Performance Assessment 1-13
1.3 Target Analytes/Parameters of Interest 1-14
1.4 Well Construction and Geologic and Geophysical Logging 1-18
1.4.1 Geologic Soil Logging 1-21
1.4.2 Radiological and Industrial Hygiene Field Screening 1-21
1.4.3 Geophysical Logging 1-21
1.4.4 Well Development 1-21

2 Quality Assurance Project Plan 2-1

2.1 Project Management 2-1
2.1.1 Project/Task Organization 2-1
2.1.2 Quality Objectives and Criteria 2-5
2.1.3 Method-Based Analysis 2-8
2.1.4 Analytical Priority 2-8
2.1.5 Special Training/Certification 2-8
2.1.6 Documentation and Records 2-9
2.2 Data Generation and Acquisition 2-10
2.2.1 Analytical Methods Requirements 2-11
2.2.2 Field Analytical Methods 2-16
2.2.3 Quality Control Requirements 2-16
2.2.4 Measurement Equipment 2-26
2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance 2-26
2.2.6 Instrument/Equipment Calibration and Frequency 2-29
2.2.7 Inspection/Acceptance of Supplies and Consumables 2-29
2.2.8 Nondirect Measurements 2-29
2.2.9 Data Management 2-29

2.3 Assessment and Oversight 2-30
2.3.1 Assessments and Response Action 2-30
2.3.2 Reports to Management 2-30
2.4 Data Review and Usability 2-30
2.4.1 Data Review and Verification 2-30
2.4.2 Data Validation 2-31
2.4.3 Reconciliation with User Requirements 2-31
3 Field Sampling Plan 3-1
3.1 Sampling Objectives/Design 3-1
3.2 Sample Location, Frequency, and Constituents 3-1
3.2.1 Sample Location 3-2
3.2.2 Frequency 3-3
3.2.3 Constituent/Parameters 3-8
3.3 Sampling Methods 3-8
3.3.1 Decontamination of Sampling Equipment 3-9
3.3.2 Radiological Field Data 3-10
3.4 Documentation of Field Activities 3-11
3.4.1 Corrective Actions and Deviation for Sampling Activities 3-12
3.5 Calibration of Field Equipment 3-12
3.6 Sample Handling 3-12
3.6.1 Containers 3-13
3.6.2 Container Labeling 3-13
3.6.3 Sample Custody 3-13
3.6.4 Sample Transportation 3-14
4 Management of Waste 4-1
5 Health and Safety 5-1
6 References 6-1

Appendices

A DQO Systematic Planning Record for WMA C Wells ..... A-i
B DQO Systematic Planning Record for B Pond Well ..... B-i

Figures

Figure 1-1. Location Map of Hanford Site, Central Plateau, and 200 East Area 1-2
Figure 1-2. Location Map of WMA C, 216-B-3 Pond, and Planned Groundwater Monitoring Wells 299-E27-40, 299-E27-27, and 699-43-43B in the 200 East Area 1-3
Figure 1-3. Well Corrosion and Large Gravel in Groundwater Monitoring Well 699-43-44 at the 216-B-3 Pond 1-4

Figure 1-4. Stratigraphy of the Hanford Site 1-6
Figure 1-5. Stratigraphic Correlation in Decommissioned Groundwater Monitoring Well 699-43-44 in 216-B-3 Pond 1-9
Figure 1-6. Stratigraphic Correlation in Decommissioned Groundwater Monitoring Well 299-E27-4 at WMA C 1-11
Figure 1-7. Preliminary Generic Design of Deep Groundwater Monitoring Well 1-19
Figure 1-8. Preliminary Generic Design of Shallow Groundwater Monitoring Well 1-20
Figure 2-1. Project Organization 2-2
Figure 3-1. Location Map of Groundwater Monitoring Wells 3-2
Figure 3-2. 299-E27-40 Sample Design (Including 299-E27-27) 3-5
Figure 3-3. 699-43-43B Well Sample Design 3-7

Tables

Table 1-1. Estimated Upper Geologic Contacts and Depths to Water 1-7
Table 1-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C 1-14
Table 1-3 Target Analytes and Geotechnical Soil Properties of Interest for 216-B-3 Pond 1-17
Table 2-1. Data Quality Indicators 2-5
Table 2-2. Change Control for Sampling Projects 2-9
Table 2-3. Performance Requirements for Soil and Water Analysis 2-11
Table 2-4. Quality Control Samples 2-16
Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria 2-17
Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes 2-27
Table 3-1. Generic Sample Design for Groundwater Monitoring Wells 299-E27-40 and 299-E27-27 3-3
Table 3-2. Generic Sample Design for Groundwater Monitoring Well 699-43-43B 3-6

This page intentionally left blank.

Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CCU	Cold Creek unit
CPGWM	Central Plateau Groundwater Model
DOE	U.S. Department of Energy
DOE-RL	DOE, Richland Operations Office
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FSO	Field Sample Operations
FSP	field sampling plan
FTB	full trip blank
FXR	field transfer blank
FWS	Field Work Supervisor
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HEIS	Hanford Environmental Information System
Hf3	Hanford formation unit 3
IATA	International Air Transportation Association
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
PUREX	Plutonium-Uranium Extraction Plant
QA	quality assurance
QAPjP	quality assurance project plan

QC	quality control
QSM	Quality Systems Manual
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
Rwia	Ringold Formation member of Wooded Island-unit A
Rwie	Ringold Formation member of Wooded Island-unit E
SAP	sampling and analysis plan
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WMA	waste management area

1 Introduction

At the Hanford Site in southeastern Washington State, the installation of Milestone M-24-00 groundwater monitoring wells is negotiated annually by the Washington State Department of Ecology (Ecology), U.S. Department of Energy (DOE), and U.S. Environmental Protection Agency (EPA) pursuant to the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a; hereinafter called the Tri-Party Agreement). The Tri-Party Agreement is a comprehensive cleanup and compliance agreement applicable to *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) waste sites and *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal units on the Hanford Site.

This sampling and analysis plan (SAP) describes characterization efforts planned during the drilling and construction of three Milestone M-24-00 groundwater monitoring wells (299-E27-40, 299-E27-27, and 699-43-43B). Wells 299-E27-40 and 299-E27-27 shall support groundwater monitoring at Waste Management Area (WMA) C, while well 699-43-43B will support groundwater monitoring at the 216-B-3 Pond. Wells 299-E27-40 and 699-43-43B are interim status RCRA wells that are currently required in the groundwater monitoring networks to replace two corroded stainless steel groundwater monitoring network wells, decommissioned in calendar year 2017 because of impacts on the quality of groundwater samples. Groundwater monitoring well 299-E27-27 is also planned to support RCRA groundwater monitoring at WMA C. Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, sampling and analysis will also be performed to support various Hanford Site programs such as CERCLA interim action (including extraction well placement), performance assessment fate and transport modeling, assessment of well corrosion, and a cumulative impacts evaluation. Data needs from various Hanford Site programs are integrated into this SAP to create efficiencies and reduce costs.

Characterization activities described in this plan (during drilling and well construction) are based on implementation of the data quality objectives (DQO) process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*) and are documented in Appendices A and B for WMA C and the 216-B-3 Pond, respectively. After characterization (i.e., sampling and analysis) and well construction are complete, the RCRA groundwater monitoring plans for WMA C and 216-B-3 Pond will be updated to include the three new wells. Groundwater monitoring at wells 299-E27-40 and 299-E27-27 shall be conducted in accordance with DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C,* while groundwater monitoring at well 699-43-43B shall be conducted according to DOE/RL-2008-59, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond,* as updated.

Figure 1-1 shows the location of the Hanford Site, including the Central Plateau and 200 East Area. Figure 1-2 shows the locations of WMA C, the 216-B-3 Pond, and planned groundwater monitoring wells 299-E27-40, 299-E27-27, and 699-43-43B in the 200 East Area. Figure 1-3 shows an example of groundwater monitoring well corrosion within the riser pipe of stainless steel casing.

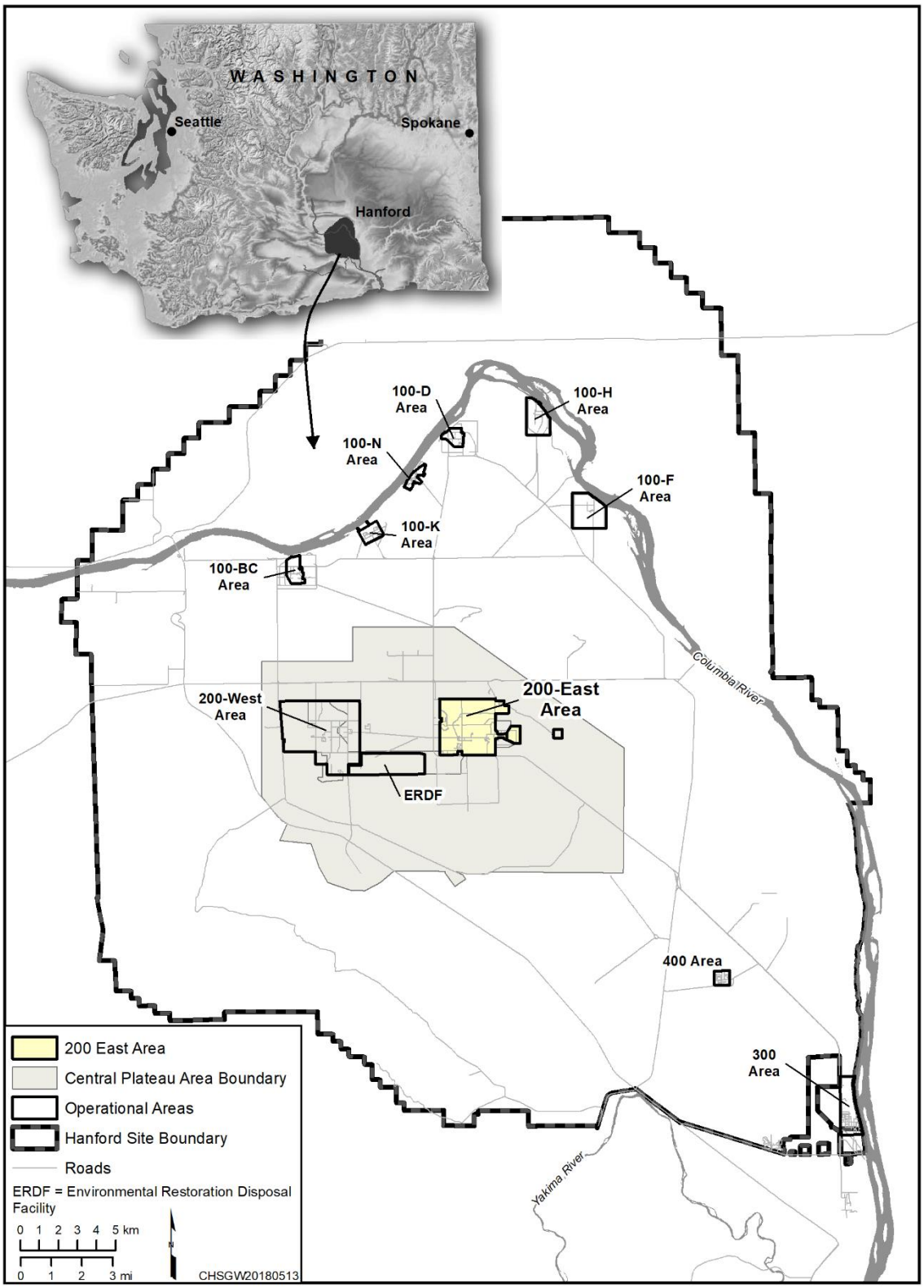


Figure 1-1. Location Map of Hanford Site, Central Plateau, and 200 East Area

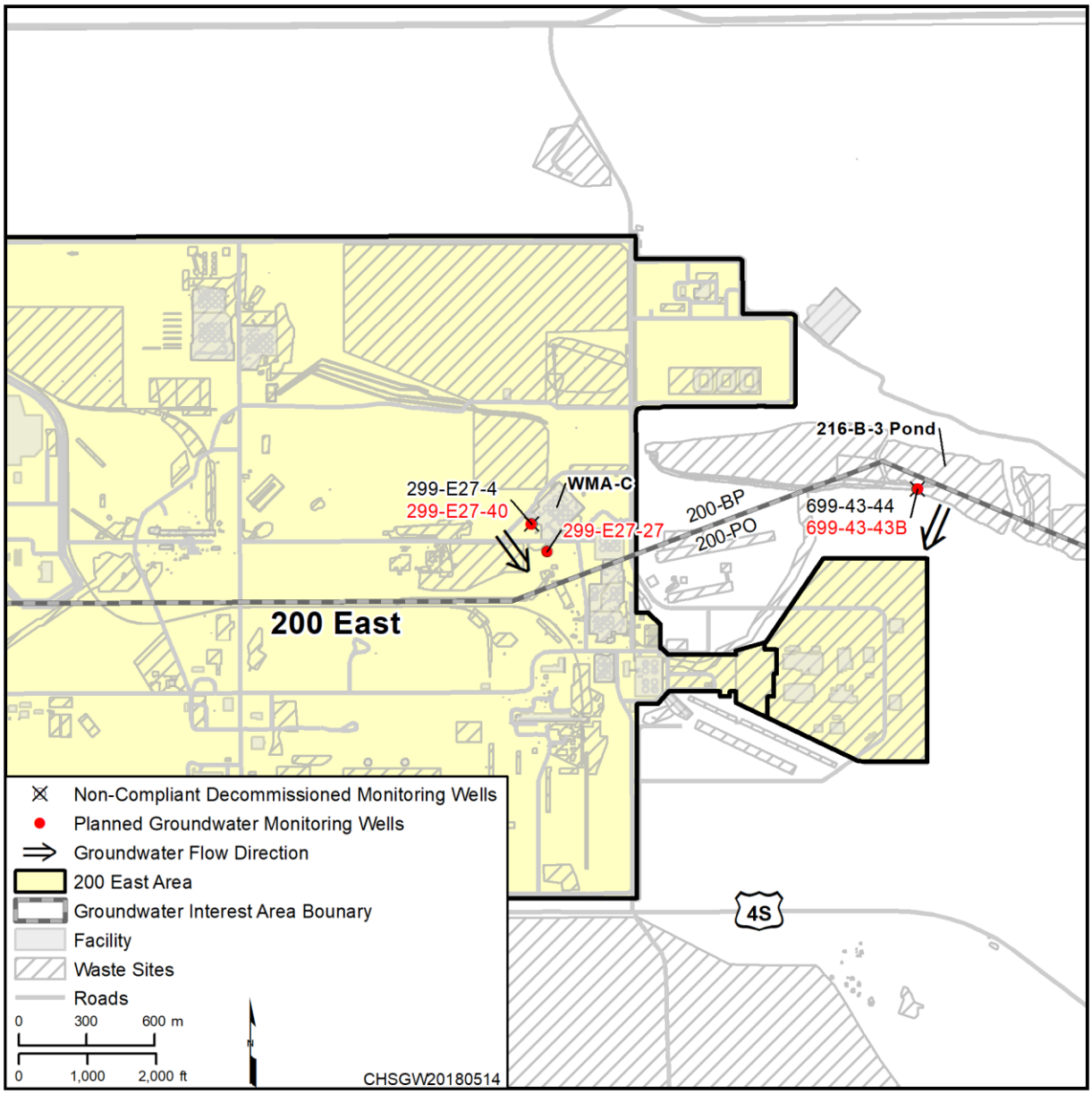
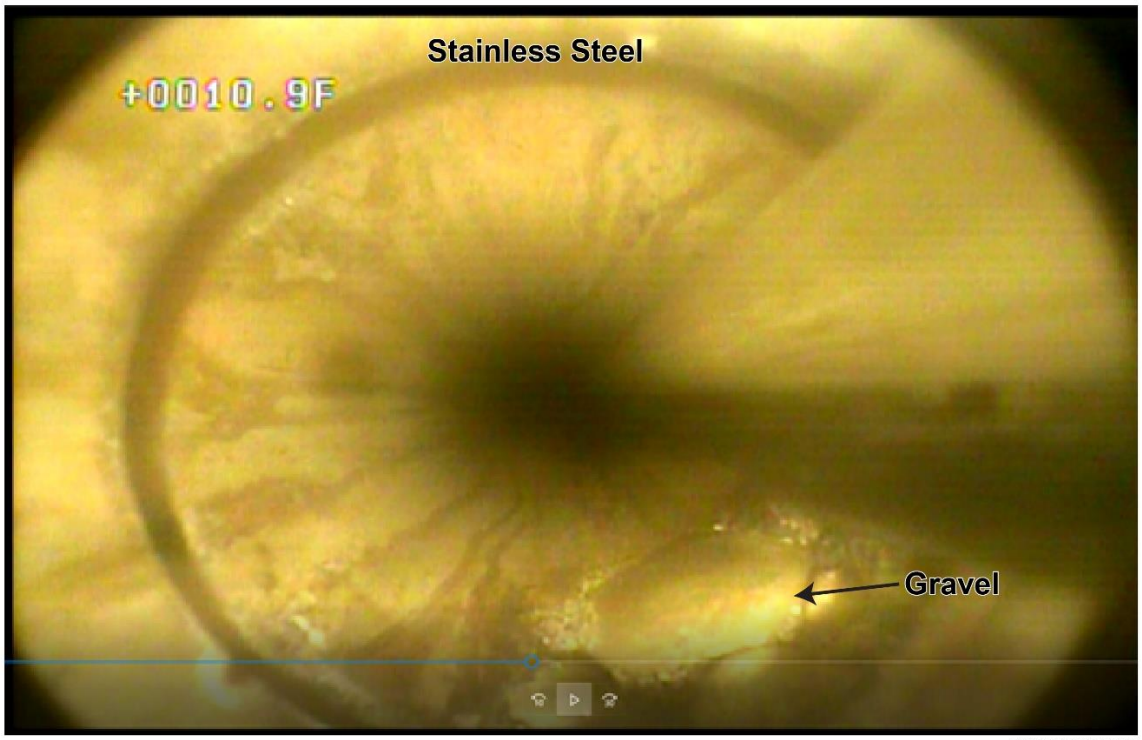


Figure 1-2. Location Map of WMA C, 216-B-3 Pond, and Planned Groundwater Monitoring Wells 299-E27-40, 299-E27-27, and 699-43-43B in the 200 East Area



CHSGW20180559

Figure 1-3. Well Corrosion and Large Gravel in Groundwater Monitoring Well 699-43-44 at the 216-B-3 Pond

1.1 Project Scope and Objectives

This SAP describes characterization activities to be performed during the drilling and construction of groundwater monitoring wells 299-E27-40, 299-E27-27, and 699-43-43B. Drilling and well construction shall be performed to provide access to the subsurface environment for the purpose of characterization and to evaluate potential releases of hazardous waste to the underlying unconfined aquifer. The scope of activities includes sampling and analysis of vadose zone soil, pore water, aquifer sediments, and groundwater; geologic logging; geophysical logging; and well development. Extensive vadose zone and groundwater sampling and analysis will be conducted during the drilling of well 299-E27-40 at WMA C. Contaminant vertical profiling is planned in the aquifer at well 299-E27-27. Limited vadose zone and aquifer characterization will be performed at well 699-43-43B at the 216-B-3 Pond. After well construction is complete, groundwater monitoring shall be performed pursuant to the RCRA and regulatory agency approved groundwater monitoring plans. However, long-term groundwater monitoring is not within the scope of this plan.

1.2 Background and Setting

This chapter describes geologic information relevant to the drilling and well construction at the 216-B-3 Pond and WMA C. Expected geologic contacts and depths to water at planned groundwater monitoring wells are provided. Background information regarding the facility description and history of 216-B-3 Pond and WMA C and the groundwater monitoring wells being replaced is also provided.

1.2.1 Geology

The geology discussion in this section is based on the following:

- CP-60925, *Model Package Report: Central Plateau Vadose Zone Geoframework Version 1.0*
- DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*
- ECF-HANFORD-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington, Fiscal Year 2016 Update*
- Lindsey, 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- PNNL-14753, *Groundwater Data Package for Hanford Assessments*
- WHC-MR-0391, *Field Trip Guide to the Hanford Site*

Information specific to the planned construction of groundwater wells is based on the local geology.

Sedimentary deposits of the Hanford Site (in descending order) include Holocene eolian sand, Hanford formation, Cold Creek unit (CCU), and Ringold Formation. These strata overlie basalt of the Columbia River Basalt Group. Figure 1-4 shows the stratigraphy and hydrostratigraphic units of the Hanford Site.

Holocene eolian sand is present at the surface over much of the Hanford Site. These generally <3 m (9.4 ft) thick, windblown, recent deposits consist of very fine- to medium-grained sand to occasionally silty sand.

Where Holocene sand and exposures of basalt are not present at the surface at the Hanford Site, the Hanford formation is present. The Hanford formation consists of uncemented gravel, sands, and silts deposited by cataclysmic floodwaters 13,000 to 1,000,000 years ago. These basalt-rich glaciofluvial deposits are divided into three sequences: gravel-, sand-, and silt-dominated. The gravel-dominated sequence consists of cross-stratified, coarse-grained sands and granule to boulder gravel that contain minor intercalated silts. The gravels are uncemented and matrix poor. The gravel-dominated sequence is identified as two units (Hanford formation unit 1 and Hanford formation unit 3 [Hf3]) where Hanford formation unit 2 is present. Hanford formation unit 1 and Hf3 are present at 216-B-3 pond. Only the Hf3 gravel is interpreted to be present at the WMA C wells. The Hanford formation unit 2 sand consists of well-stratified fine- to coarse-grained sand and granule gravel and is present at 216-B-3 Pond and WMA C. Silt in this sequence is variable and may be interbedded with the sand. Where the silt content is low, an open framework texture is common. The silt-dominated sequence consists of interbedded silts and fine- to coarse-grained sand forming well-stratified graded rhythmites and is not present near planned wells.

The CCU underlies the Hanford formation as shown in Figure 1-4. Deposited 1 to 3.9 million years ago, the CCU consists of windblown unconsolidated muddy fine sand to fine sandy mud and very hard rock that formed during soil development from evaporation of calcium bearing meteoric water. This calcrete facies—Cold Creek unit caliche—is locally referred to as the “caliche layer” and is a major impediment to vertical migration of water. This caliche layer will likely not be encountered in planned wells. A gravel-dominated sequence of Cold Creek unit gravel has been interpreted to be present at the 216-B-3 Pond and WMA C.

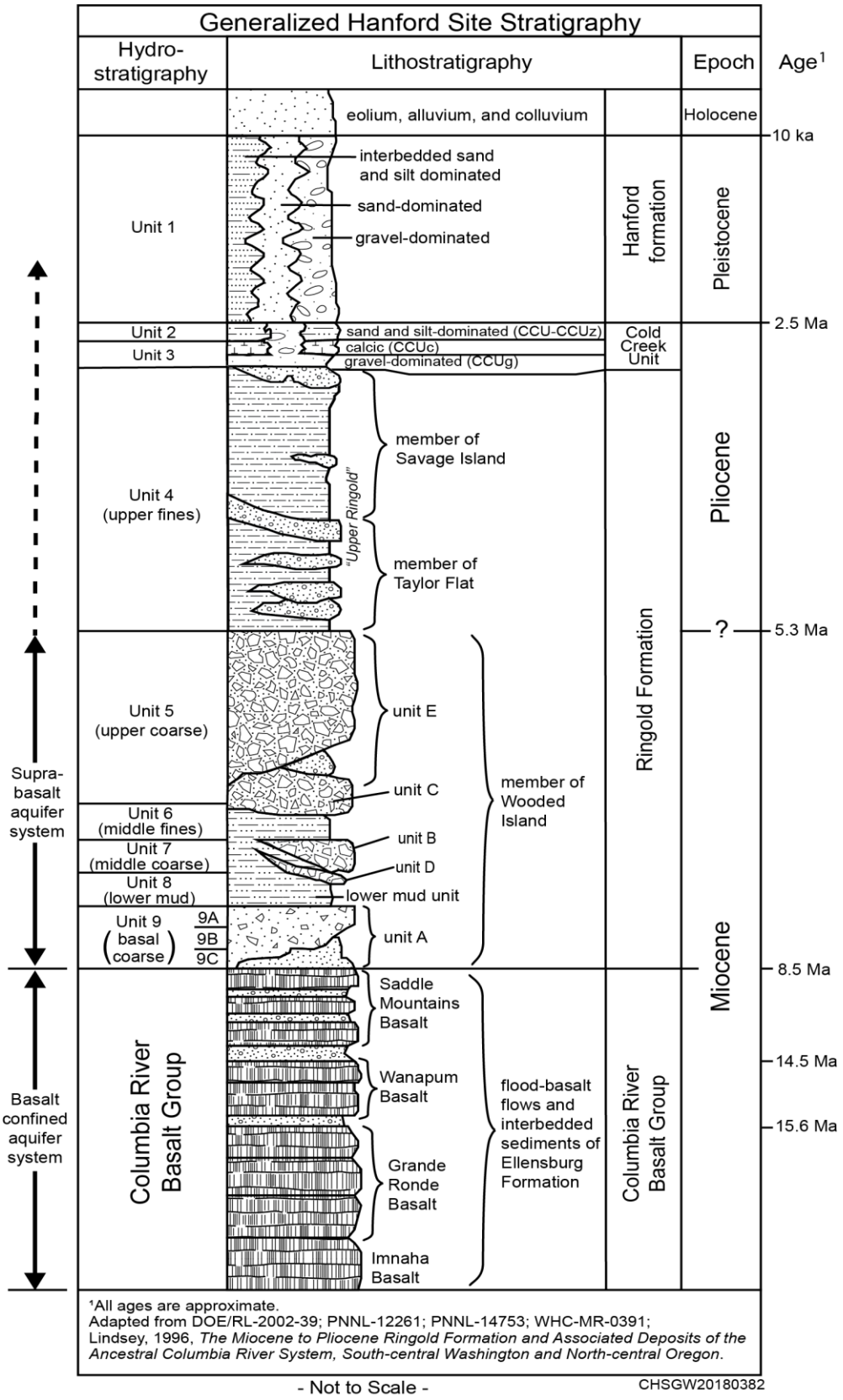


Figure 1-4. Stratigraphy of the Hanford Site

In many areas of the Hanford Site, the Ringold Formation underlies the CCU. Where the CCU is not present, the Ringold Formation typically underlies the Hanford formation. The Ringold Formation is an interstratified sequence of unconsolidated clay, silt, sand, gravel-to-cobble gravel deposited by the ancestral Columbia River. Deposited 3.9 to 10 million years ago, the Ringold Formation consists of up to four major units across most of the Hanford Site: overbank-dominated deposits of the member of Taylor Flat, fluvial gravels of the member of Wooded Island - unit E (Rwie), paleosol and lacustrine muds of the member of Wooded Island - lower mud unit, and fluvial gravels of the member of Wooded Island - unit A (Rwia).

Ringold Formation member of Taylor Flat consists of an abundance of well-sorted sand to muddy sand and gravelly sand. Deposition of this unit represents transition to a lower energy fluvial environment compared to Rwie. Rwie and Rwia consist mostly of coarse-grained gravel and sand deposited in a high-energy fluvial environment. Clasts supported gravels consisting of quartzite, porphyritic volcanic, and other exotics from outside the basin with a mix of quartz-feldspathic sands and mud typically characterize Rwie and Rwia. However, silt lithologies over 3 m (10 ft) thick are documented associated with Rwia. The Ringold Formation member of Wooded Island - lower mud unit typically represents the base of the unconfined aquifer, where present beneath the water table. This unit is predominantly silt with approximately equal amounts of sand and clay. At 216-B-3 Pond, a silt unit associated with Rwia is interpreted to be the base of the unconfined aquifer.

The Elephant Mountain Member of the Columbia River Basalt Group is the uppermost basalt unit (i.e., bedrock) beneath the 200 East Area. The Elephant Mountain Member is dated about 10.5 million years before present.

The water table intersects the Rwia at 216-B-3 Pond about 55.5 m (182 ft) below ground surface (bgs) at planned well 699-43-43B. The CCU intersects the water table about 84 m (276 ft) bgs in planned wells 299-E27-40 and 299-E27-27. Table 1-1 shows the estimated stratigraphic contacts and depth to water in the planned groundwater monitoring wells.

Table 1-1. Estimated Upper Geologic Contacts and Depths to Water

Well Name	Facility	DTW ft bgs	Hanford Formation* ft bgs			Cold Creek Unit Gravel ft bgs	Ringold Formation ft bgs	Basalt ft bgs
			Hanford formation Unit 1	Hanford formation Unit 2	Hanford formation Unit 3			
299-E27-40 and 299-E27-27	WMA C	276	NP	0	241	254	NP	323
699-43-43B	216-B-3 Pond	182	0	13	107	141	Rwia Silt 161	208

*Holocene eolian sand may be present at the surface.

bgs = below ground surface
DTW = depth to water
NP = not present
WMA = Waste Management Area

1.2.2 216-B-3 Pond Waste Site Description and History

The 216-B-3 Pond operated from 1945 to 1994 and received 1.0×10^{12} L (260 billion gal) of effluent (predominately water used for cooling that did not contact contamination). Located in a natural topographic depression, the approximately 14.2 ha (35 ac) pond had a maximum depth of approximately 6.1 m (20 ft) and was used for evaporation and percolation of effluent. Four ditches were used to convey effluent from production facilities in the 200 East Area to the pond. The 216-B-3-1 Ditch operated from 1945 to 1964, the 216-B-3-2 Ditch operated from 1964 to 1970, and the 216-B-3-3 Ditch operated from 1970 to 1994. The 216-B-3-3 Ditch also received effluent from the 216-A-29 Ditch that was directed to the pond. In 1994, the pond was filled with clean soil during interim stabilization activities. All vegetation was removed from the perimeter and incorporated with the fill soil.

During operations, the 216-B-3 Pond received effluent from several 200 East Area facilities, including the Plutonium-Uranium Extraction Plant (PUREX), B Plant, 241-A 401 Building, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant. Small quantities of corrosive hazardous wastes such as nitric and sulfuric acids were routinely discharged to the pond via the ditches. Other dangerous waste discharged to the pond included chlorides, cadmium nitrate, ammonium fluoride, ammonium nitrate, hydrazine, and sodium and potassium hydroxide. DOE/RL-2008-59 provides a detailed discussion of the 216-B-3 Pond.

1.2.3 Decommissioned Groundwater Monitoring Well 699-43-44 at 216-B-3 Pond

Groundwater monitoring well 699-43-44 was constructed within the 216-B-3 Pond in 1999 after interim stabilization. The well (screen and riser pipe) was constructed of grade 304 stainless steel and the annular space was filled (sand, bentonite, and grout) consistent with standard well construction requirements. Well 699-43-44 was decommissioned in September 2017 because of corrosion in the riser pipe and is being replaced by well 699-43-43B. During drilling of decommissioned well 699-43-44, 14 soil samples were collected to characterize the nature and extent of contamination and analyzed for anions; ammonia; nitrogen in nitrite and nitrate; metals; hexavalent chromium; mercury; volatile organic compounds; semivolatile organic compounds; polychlorinated biphenyl; cyanide; pH; tritium; nickel-63; americium-241; cesium-137; cobalt 60; europium-152, -154, and -155; neptunium-237; plutonium-238 and -239/240; strontium-90; technetium-99; thorium-232; total uranium and uranium-233/234, -235/236, and -238; and total petroleum hydrocarbon. Characterization of the 216-B Pond at well 699-43-44 is further described in BHI-01367, *200-CW-1 Operable Unit Borehole/Test Pit Summary Report*.

Constituents analyzed in well 699-43-44 that could contribute to the corrosion of stainless steel include chloride, sulfate, sulfide, and pH. Chloride and sulfate concentrations in soil samples were less than background soil concentrations. The maximum concentration of sulfide was 4.6 mg/kg and detected below the depth of any corrosion. Measurements of pH in the vadose zone were in the basic range (8.2 to 9.7). This hydrogen ion range would contribute to the corrosion resistance of stainless steel. According to Sedriks, 1996, *Corrosion of Stainless Steel*, chloride resistance of type 304L stainless steel under conditions of high pH (approximately 12.5) could be in excess of 10,000 mg/L chloride.

A zone of high moisture (up to 25% volumetric) is noted about 7.6 to 10.4 m (25 to 34 ft) bgs within a sand lithology that contains about 20% silt. This extremely high zone of moisture, which may be described as waterlogged, is not typical of the moisture content in the vadose zone at the Hanford Site, which commonly ranges from 5% to 12%. This high zone of moisture is correlative to major areas of corrosion within the well and use of bentonite in the annular. Elevated levels of moisture and corrosion are also noted about 3.4 m (11 ft) bgs and 21.6 m (71 ft) bgs. Figure 1-5 shows the geology in well 699-43-44 with stratigraphic correlation to the water table, sample design, well construction design, corrosion, and high moisture in the vadose zone.

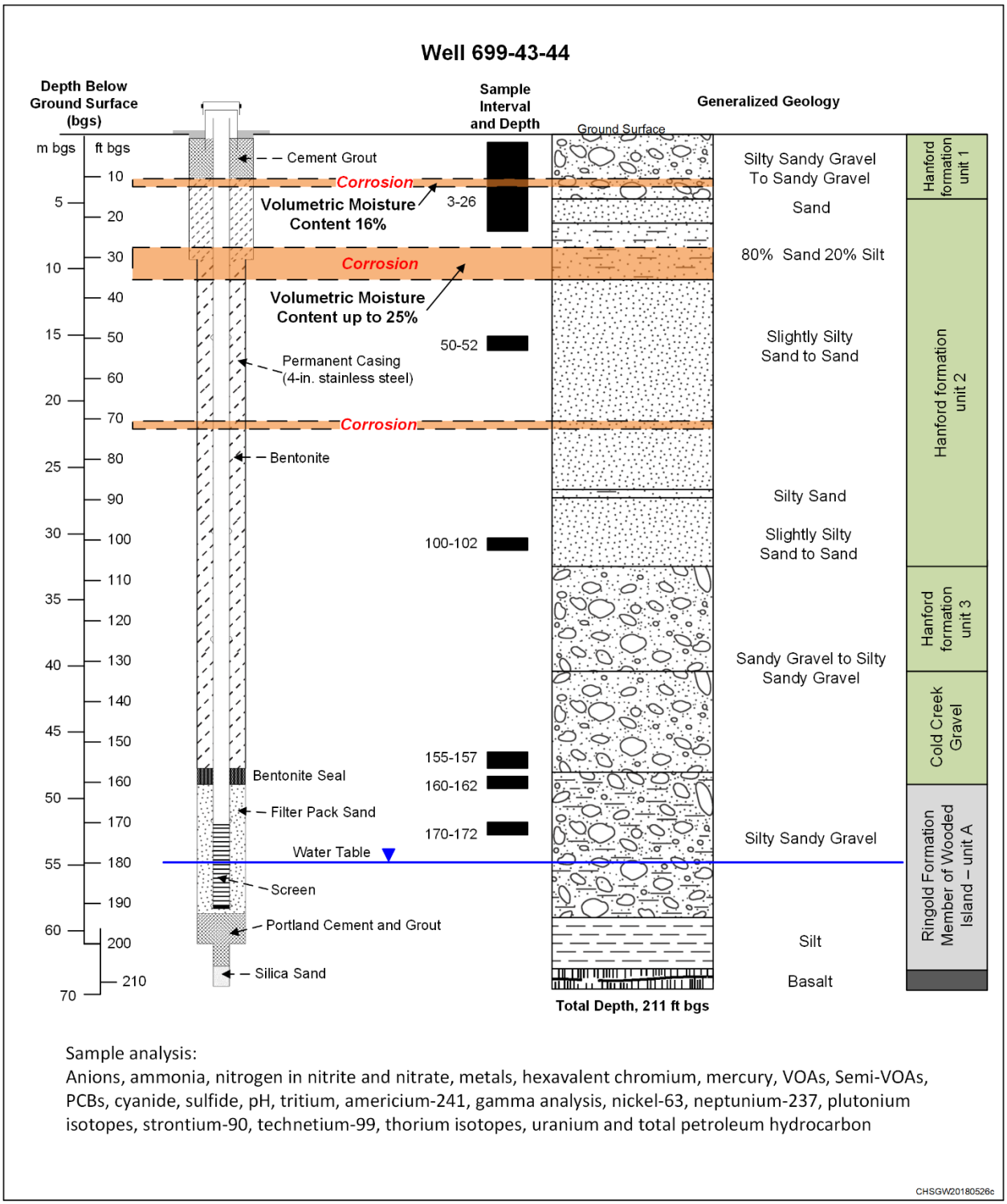


Figure 1-5. Stratigraphic Correlation in Decommissioned Groundwater Monitoring Well 699-43-44 in 216-B-3 Pond

1.2.4 WMA C Waste Site Description and History

Several reports describe the history and construction of WMA C and the 241-C Tank Farms. The information in this section is mainly from RPP-RPT-48029, *Completion Report for Direct Push Characterization at Four Sites in the 241-C Tank Farm.*

The Hanford Site has 149 underground single-shell tanks that store hazardous radioactive waste. The tanks are grouped into 12 tank farms and further divided into 8 WMAs regulated under RCRA. Many of the tanks have leaked. Leaks have also occurred from the associated infrastructure of pipelines and diversion boxes in and adjacent to the farm.

WMA C encompasses the 241-C Tank Farm and its boundary is the fence line surrounding the facility (Figure 1-2). The WMA C provided interim storage of radioactive waste, primarily from the bismuth-phosphate process, the PUREX process, and the uranium extraction process. WMA C was constructed from 1944 to 1945 and was used in the late 1940s onward. WMA C contains 16 underground single-shell tanks: 100-series (12) and 200-series (4) tanks. The 100-series tanks are 23 m (75 ft) diameter with an operating depth of 5 m (15 ft) and a storage capacity of 1,892,700 L (530,000 gal). The 200-series tanks are 6 m (20 ft) in diameter with a 7.3 m (24 ft) operating depth and a storage capacity of 208,000 L (55,000 gal). The tanks are positioned below grade with at least 2 m (7 ft) of soil to shield personnel from radiation exposure. WMA C also includes the 244-CR vault, eight diversion boxes, and various piping. Pits are located on the top of the tanks and provide access to the tanks, pumps, and monitoring equipment.

1.2.5 Decommissioned Groundwater Monitoring Well 299-E27-4 at WMA C

Groundwater monitoring well 299-E27-4 was constructed adjacent to WMA C on August 20, 2003. Like well 699-43-44, the well (screen and riser pipe) was constructed of grade 304 stainless steel, and the annular space was filled (sand, bentonite, and grout) consistent with standard well construction requirements. Because of corrosion in the riser pipe, the well was decommissioned December 11, 2017, and is being replaced by 299-E27-40. Corrosion is documented about 9.7 to 15.8 m (32 to 52 ft) bgs. Pitting on the casing appears to be the major type of corrosion in the well. The amount of iron staining observed on the interior well casing indicates high moisture content in the surrounding soil. No analytical data is available to evaluate potential contamination in the vadose zone and the geotechnical soil properties (i.e., physical and hydraulic) adjacent to the well.

Figure 1-6 shows the geology in the decommissioned well with stratigraphic correlation to the water table, well construction design, and corrosion.

SGW-59914, *WMA C January Through March 2016 Quarterly Groundwater Monitoring Report*, provides a potential rationale for the corrosion in well 299-E27-4. In summary, well 299-E27-4 is positioned next to decommissioned pipeline V108 (812), buried at a depth about 2.4 m (8 ft). The pipeline released 65,800 L (17,385 gal) of PUREX sludge supernatant to the surrounding soil in February 1971. The solution originated from the 241-C-106 tank and was released at a pipe connection approximately 43.5 m (143 ft) south of well 299-E27-4.

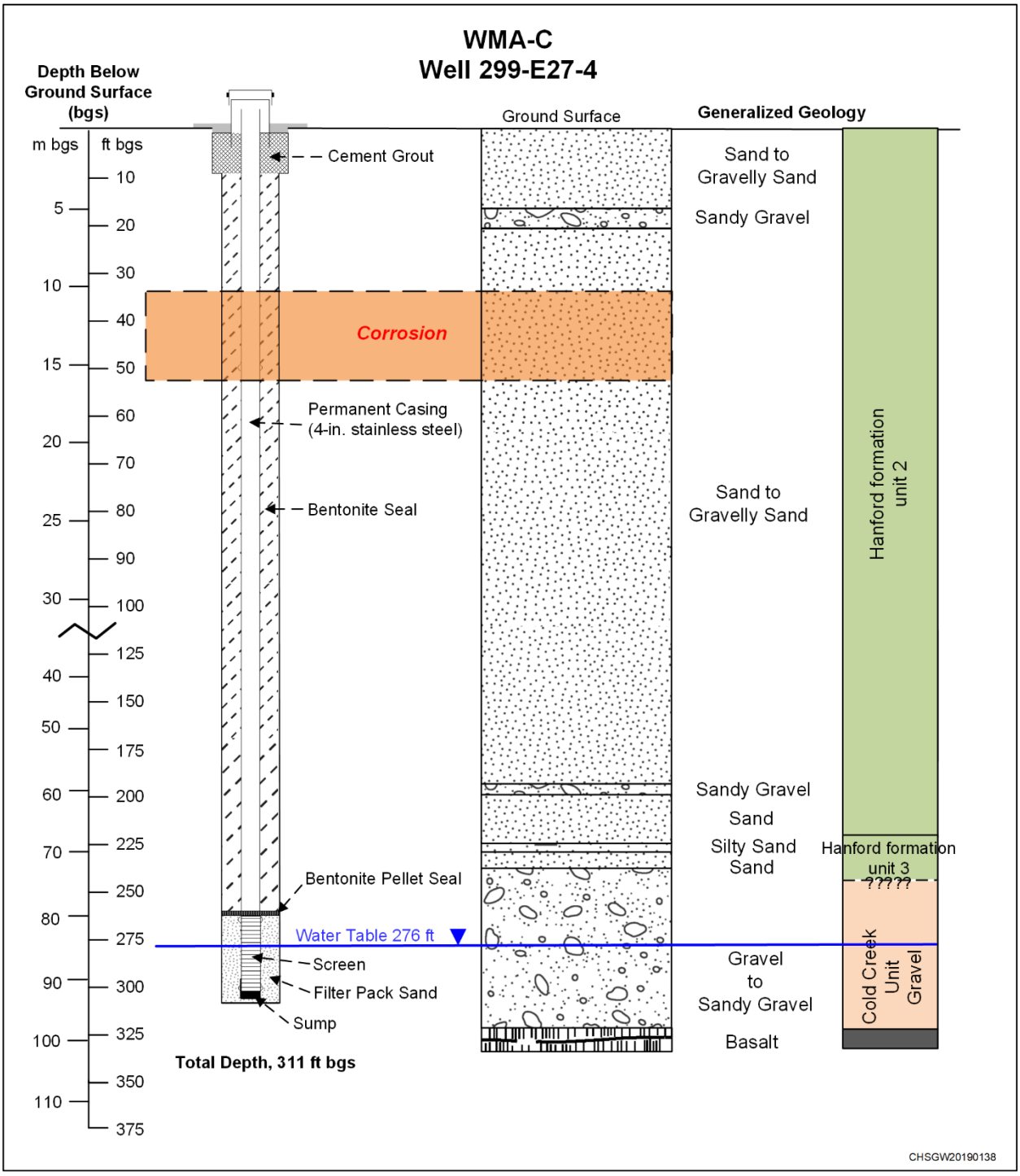


Figure 1-6. Stratigraphic Correlation in Decommissioned Groundwater Monitoring Well 299-E27-4 at WMA C

The PUREX sludge supernatant was composed primarily of a solution of sodium nitrate and sodium nitrite with less sodium pertechnetate and sodium diuranate. The solution contained 0.7 M nitrate, 1.8 x 10^{-3} M of uranium, and technetium at 1.1 x 10^{-5} M. The chloride content of PUREX sludge supernatant is considered approximately 0.002 M, which is significantly >500 parts per million (ISO-986, *B-Plant Phase III Flowsheets*). PNNL-13690, *Selection of Sampling Pumps Used for Groundwater Monitoring at the Hanford Site*, suggests the chemistry of the effluent release in the presence of >500 parts per million chloride could lead to stainless steel corrosion. Thus, it seems likely that PUREX sludge supernatant solution migrating into the sediments near well 299-E27-4 may have contributed to accelerated casing corrosion. The availability of moisture in the vadose zone, as indicated by iron staining migrating down the interior well casing and the chloride leached from bentonite in the annular seal, also likely contributed to corrosion as suggested by PNNL-15141, *Investigation of Accelerated Casing Corrosion in Two Wells at Waste Management Area A-AX*. The 812 line may have provided a conduit for migration from the release point to the soils near well 299-E27-4.

1.2.6 Groundwater Monitoring Well 299-E27-27

Groundwater water monitoring well 299-E27-27 is planned to support final status groundwater monitoring in WMA C. The location of this new well is based on evaluation of contaminants, the expected migration behavior of contaminants, and historical observations and measurements of groundwater contamination and groundwater transport simulations using the Central Plateau Groundwater Model (CP-47631, *Model Package Report: Central Plateau Groundwater Model Version 8.3.4*). Characterization needs for this new well are incorporated into this SAP.

1.2.7 Stainless Steel Wells and Corrosion

Hanford Site groundwater monitoring wells are typically constructed with stainless steel because of the material's resistance to corrosion (rusting). Sand, bentonite (a chloride source), and cement are normally used in the annular space to seal wells. Chromium is the main component of stainless steel that provides the corrosion resistance. However, nickel, molybdenum, and reduced carbon content of the material combined with iron contributes to corrosion resistance.

Groundwater monitoring wells on the Hanford Site are constructed with one of the following stainless steel types: 304, 304L, 316, or 316L. Most of the wells are constructed with 304 stainless steel containing 18% chromium and 8% nickel. These wells have a long history of continuous use in the dry environment of the Hanford Site where the moisture content ranges from 5 to 12% in the vadose zone. The corrosion resistance of stainless steel improves with grade 304L stainless steel. In the manufacturing process, 304L (304 with less carbon) is produced by removing carbon from the steel to create a more corrosion resistant material compared to 304. 316 stainless steel (16% chromium, 10% nickel, and 2% molybdenum) offers greater resistance to rusting than 304 and 304L stainless steel, while 316L (316 with less carbon) offers the best resistance to corrosion because of less carbon.

Corrosion resistance is achieved by the formation of a thin surface film known as a "passive film," which acts as a protective barrier by providing electrochemical impedance at the air/solution: metal interface (PNNL-15141). For stainless steels, the passive film is composed primarily of bound water, oxygen, and hydroxide ions, and typically chromium ions bonded to oxygen to form an "oxide" (Lacombe et al., 1993, "Stainless Steels"). Ultimately, the degree of corrosion protection is based on the efficacy of the passive film to regulate the ion exchange of matter between the metal and the solution (PNNL-15141). Breakdown of the passive film is promoted in the presence of chlorides (halogen salts group 17 on the periodic chart), oxygen in stagnant solutions, acids and debris in contact with the stainless steel.

Under saturated or near-saturated conditions, PNNL-15141 suggests that bentonite used to seal the annular space in groundwater monitoring wells is capable of generating chloride concentrations in excess of 700 mg/L. The testing in the laboratory also indicated that chloride concentrations >100 mg/L are sufficient to cause corrosion of stainless steel. In practice, this information means the available chloride, from bentonite and effluent discharged to the soil column in the presence of iron, can be sufficient to breakdown the passive film and cause corrosion. Conversely, testing of the annular material Portland cement and pore water shows chloride concentrations were under the 100 mg/L threshold to cause corrosion.

This information suggests use of Portland cement and better grades of stainless steel for well construction may prevent accelerated well corrosion in the saturated or near-saturated soil near WMA C and 216-B-3 Pond.

1.2.8 CERCLA Interim Actions/Cumulative Impact Evaluation

Waste sites on the Central Plateau (200 Areas) were created by discharging liquid effluent and managing solids within the soil column at ponds, ditches, cribs, and burial grounds. Intentional and unintentional releases have impacted the vadose zone and aquifer. Monitoring, characterization, and cleanup of waste sites and groundwater in the 200 Areas are being addressed mainly by CERCLA and RCRA actions. Cleanup of waste sites (vadose zone), facilities, and groundwater were initiated with signing of the Tri-Party Agreement in 1989. Thirty years after signing the agreement, remediation of wastes and groundwater continues.

Implementation of a cumulative impact evaluation is planned on the Central Plateau to assess impacts from multiple sources (waste sites and facilities), contaminated groundwater and cleanup decisions. Elements of the approach are described in DOE/RL-2018-69, Draft A, *Cumulative Impact Evaluation Technical Approach Document*. The document provides a generic framework of objectives required for fate and transport modeling, maintenance, and reporting needs. The goal of the evaluation is to support long term remedial and closure decisions by providing a tool to evaluate impacts from sources on groundwater. The cumulative impact evaluation is applicable to over 1300 waste sites, groundwater operable units (OUs), and processing facilities regulated under CERCLA, RCRA, and other waste disposal frameworks. Data collection described in this SAP will provide data to support the cumulative impact evaluation.

1.2.9 Performance Assessment

Fate and transport models have been developed for the WMA C PA. For the WMA C PA “base case,” vadose zone modeling using hydraulic properties from small-scale laboratory measurements were used to predict large field-scale flow behavior (RPP-RPT-58949, *Model Package Report Flow and Contaminant Transport Numerical Model used in WMA C Performance Assessment and RCRA Closure Analysis*, Appendix B). An alternative model was developed using moisture data from WMA C. Results are presented in RPP-CALC-60345, *Heterogeneous Medial Model for Waste Management Area C Performance Assessment*. The purpose of the alternative model was to characterize the heterogeneous media at WMA C using the field-measured moisture content data obtained under essentially nontransient conditions. This tool used an extensive set of moisture data from WMA C as an indicator sediment texture to develop contaminant transport models and simulate contaminant breakthrough. Ongoing development and maintenance of fate and transport tools are needed to better understand the relationship between moisture content, soil texture, and contaminant fate/transport in the vadose zone. Data collection described in this SAP will provide data to support the PA and cleanup.

1.3 Target Analytes/Parameters of Interest

Target analytes and geotechnical soil properties of interest were developed for WMA C and 216-B-3 Pond during the DQO process. Target analytes and parameters of interest are listed in Tables 1-2 and 1-3.

Table 1-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods	Media		Sample Priority
General Chemical Parameters				
Alkalinity	310.1 or Standard Method 2320	NA	Water	14
pH	150.1	Soil	Water	5
Specific conductance	9050	NA	Water	24
Ammonia and Anions				
Anions	300 or 9056	Soil	Water	1
Sulfide	376.1 or Standard Method 4500S or 9034	Soil	Water	1
Ammonia	350.1	Soil	NA	21
Metals				
ICP-AES and ICP-MS metals (includes uranium)	6010 and 6020	Soil	Water	13
Cyanide	9012 or 9014 or 335.4 or 4500-CN	Soil	NA	2
Free cyanide	9014	NA	Water	3
Mercury	7470 or 7471	Soil	Water	22
Polychlorinated biphenyls				
Polychlorinated biphenyls	8082	Soil	Water	23
Organics				
Volatile organic analysis	8260	Soil	Water	19
Semivolatile organic analysis	8270	Soil	Water	20
Total organic carbon	415.1 or 9060	Soil	Water	25
Radionuclides				
Americium-241	Alpha energy analysis	Soil	Water	17
Antimony-125	Low-energy gamma spectroscopy or gas proportional counting	Soil	Water	12

Table 1-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods	Media		Sample Priority
Carbon-14	Liquid scintillation counter	Soil	Water	16
Cesium-137	Gamma energy analysis	Soil	Water	12
Cobalt-60	Gamma energy analysis	Soil	Water	12
Curium-244	Alpha energy analysis	Soil	Water	17
Europium-152, -154, -155	Gamma energy analysis	Soil	Water	12
Iodine-129	Low-energy gamma spectroscopy or gas proportional counting	Soil	Water	15
Neptunium-237	Alpha energy analysis	Soil	Water	17
Nickel-63	Liquid scintillation counter	Soil	Water	16
Plutonium-238 -239/240, 241	Alpha energy analysis	Soil	Water	17
Selenium-79	Liquid scintillation counter	Soil	Water	16
Strontium-90	Gas proportional counting	Soil	Water	18
Technetium-99	Liquid scintillation counter	Soil	Water	16
Thorium-228, -230, -232	Alpha energy analysis	Soil	Water	17
Tritium	Liquid scintillation counter	Soil	Water	
Uranium-235/236, -238	Alpha energy analysis	Soil	Water	17
Geotechnical Soil Properties				
Unsaturated hydraulic conductivity	PNNL Analysis*	Soil	NA	6
Saturated hydraulic conductivity	PNNL Analysis*	Soil	NA	7
Matric potential using filter paper	PNNL Analysis*	Soil	NA	8
Grain size distribution	PNNL Analysis*	Soil	NA	11
Gravimetric moisture content	PNNL Analysis*/ ASTM D2216	Soil	NA	4
Bulk density	PNNL Analysis*	Soil	NA	9
Total porosity	PNNL Analysis*	Soil	NA	10

Table 1-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods	Media		Sample Priority
Field Screening				
Radiological screening by radiological control technician	Continuous in the vadose zone -Hanford Site procedure	Soil	NA	Continuous
Dissolved oxygen	Field measurement instrument/meter	NA	Water	NA
Oxidation-reduction potential	Field measurement instrument/meter	NA	Water	NA
pH	Field measurement instrument/meter	NA	Water	NA
Specific conductivity	Field measurement instrument/meter	NA	Water	NA
Temperature	Field measurement instrument/meter	NA	Water	NA
Turbidity	Field measurement instrument/meter	NA	Water	NA
Spectral gamma logging	Contractor procedure	Soil	Water	Before downsizing casing and at total depth
Neutron moisture logging	Contractor procedure	Soil	NA	Before downsizing casing and at total depth

References: APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*.

ASTM D2216, 2019, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Waste*.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI*.

Notes: Duplicate sample priority indicates constituents are likely within the same bottle.

For EPA Methods 300 and 335.4, see EPA/600/R-93/100. For EPA Methods 150.1, 310.1, 350.1, 376.1, and 415.1, see EPA-600/4-79-020. For four-digit EPA methods, see SW-846. For Standard Methods, see APHA/AWWA/WEF, 2012. Equivalent methods may be substituted.

*Geotechnical soil property samples >30.5 m (100 ft) below groundwater surface will be collected for Washington River Protection Solutions. The samples shall be transported to PNNL and analyzed for the indicated parameters according to RPP-PLAN-63020, *Sampling and Analysis Plan for WMA A-AX Focus Area 2 (Southwestern Area of A Farm)*, ASTM D2216, and ASTM D5298-16, *Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper*.

EPA = U.S. Environmental Protection Agency

ICP-AES = inductively coupled plasma-atomic emission spectroscopy

ICP-MS = inductively coupled plasma- mass spectrometry

NA = not applicable

pH = hydrogen ion concentration

PNNL = Pacific Northwest National Laboratory

WMA = waste management area

Table 1-3. Target Analytes and Geotechnical Soil Properties of Interest for 216-B-3 Pond

Nonradioactive Analytes	Analytical Methods	Media		Sample Priority
pH				
pH	150.1	Soil	NA	3
Anions				
Anions	300 or 9056	Soil	Water	1
Inorganics				
ICP-AES and ICP-MS metals (includes uranium)	6010 or 6020	Soil	Water	4
Radionuclides				
Iodine-129	Low-energy gamma or gas proportional counting	Soil	Water	6
Tritium	Liquid scintillation counter	Soil	Water	5
Geotechnical Soil Properties				
Gravimetric moisture content	ASTM D2216	Soil	NA	2
Field Screening				
Radiological screening by radiological control technician	Continuous in the vadose zone-Hanford Site procedure	Soil	NA	Continuous
Dissolved oxygen	Field measurement instrument/meter	NA	Water	NA
Oxidation-reduction potential	Field measurement instrument/meter	NA	Water	NA
pH	Field measurement instrument/meter	NA	Water	NA
Specific conductivity	Field measurement instrument/meter	NA	Water	NA
Temperature	Field measurement instrument/meter	NA	Water	NA
Turbidity	Field measurement instrument/meter	NA	Water	NA

Table 1-3. Target Analytes and Geotechnical Soil Properties of Interest for 216-B-3 Pond

Nonradioactive Analytes	Analytical Methods	Media		Sample Priority
Spectral gamma logging	Contractor procedure	Soil	Water	Before downsizing casing and at total depth.
Neutron moisture logging	Contractor procedure	Soil	NA	Before downsizing casing and at total depth.

References: ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Waste*.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI*.

Note: For EPA Method 300, see EPA/600/R-93/100. For EPA Method 150.1, see EPA-600/4-79-020. For four-digit EPA Methods, see SW-846.

EPA = U.S. Environmental Protection Agency

ICP-AES = inductively coupled plasma-atomic emission spectroscopy

ICP-MS = inductively coupled plasma-mass spectrometry

NA = not applicable

pH = hydrogen ion concentration

1.4 Well Construction and Geologic and Geophysical Logging

Well drilling and construction will be performed in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." Each well will be drilled to the base of the unconfined aquifer and backfilled to completion depth as needed. Wells will be constructed as 10.2 cm (4 in.) diameter monitoring wells with 304L or 316L grade stainless steel casing and screens to provide corrosion resistance. Polyvinyl chloride is also a construction option, but not recommended.

The screened interval in groundwater monitoring well 699-43-43B is anticipated to be no more than 6.1 m (20 ft) long and set no more than 1.52 m (5 ft) above the water table. Based on the saturated thickness of the aquifer of 3.7 m (12 ft) at 216-B-3 Pond, a shorter screen may be necessary.

Wells 299-E27-40 and 299-E27-27 will likely be constructed as a deep groundwater monitoring well design at WMA C. At the base of the unconfined aquifer (i.e., top of basalt), a screen will be set with the sump extending into the basalt. The final design and placement of the well screen will be based on an evaluation of depth to groundwater, aquifer thickness, and the maximum contaminant concentrations and particle size data collected across the saturated thickness of the aquifer. The OU technical lead will evaluate the data to support well design in conjunction with the drilling organization.

The annular space in each well will be completed with Portland cement from 30.5 m (100 ft) bgs to the surface to minimize the potential for well corrosion. If polyvinyl chloride is used for well construction and Portland cement or another material is used to seal wells 30.5 m (100 ft) bgs, the annular material shall be placed to minimize excessive heat generation.

The generic well design for deep groundwater monitoring wells 299-E27-40 and 299-E27-27 is shown in Figure 1-7. The generic well design for shallow groundwater monitoring well 699-43-43B is shown in Figure 1-8.

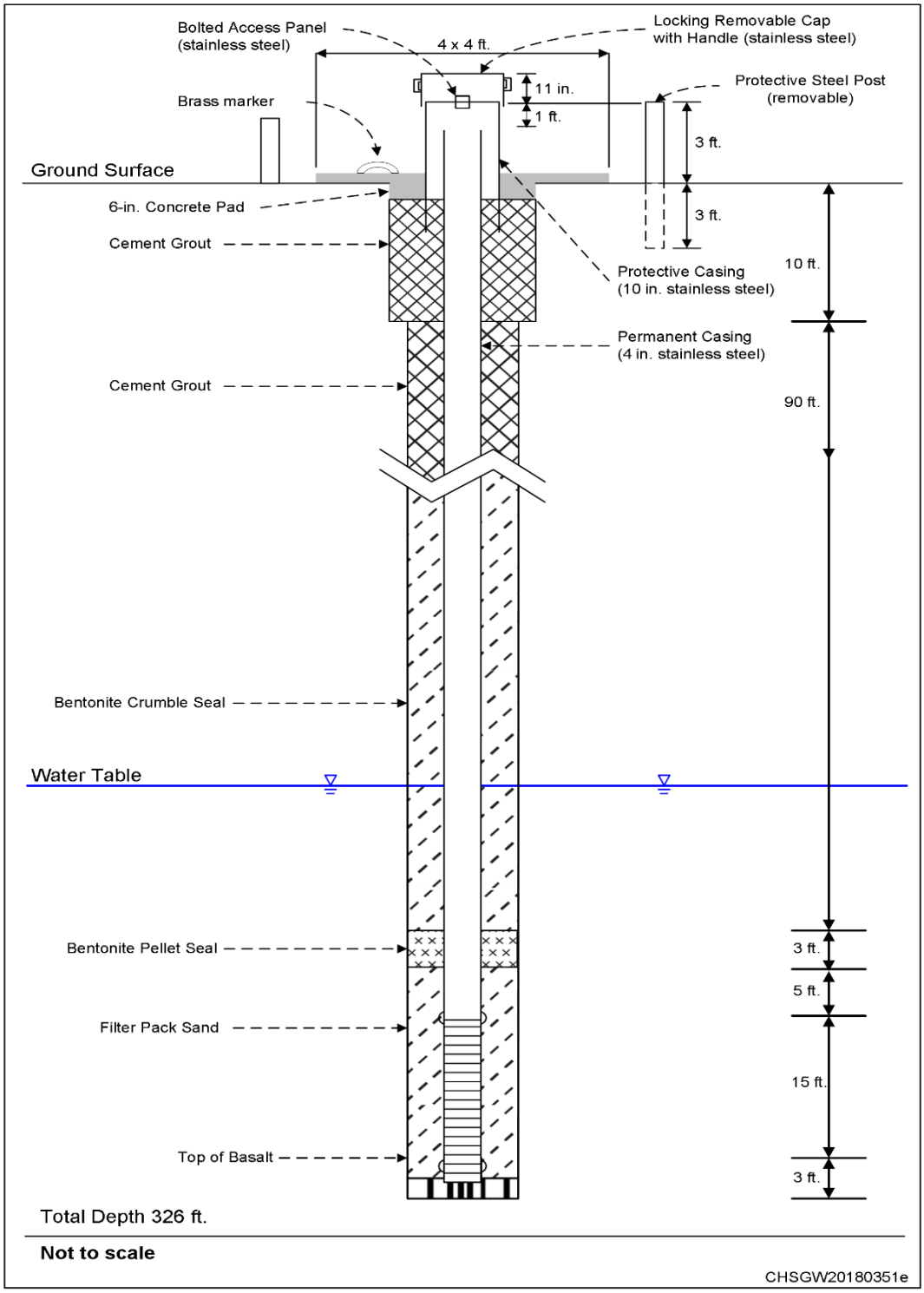


Figure 1-7. Preliminary Generic Design of Deep Groundwater Monitoring Well

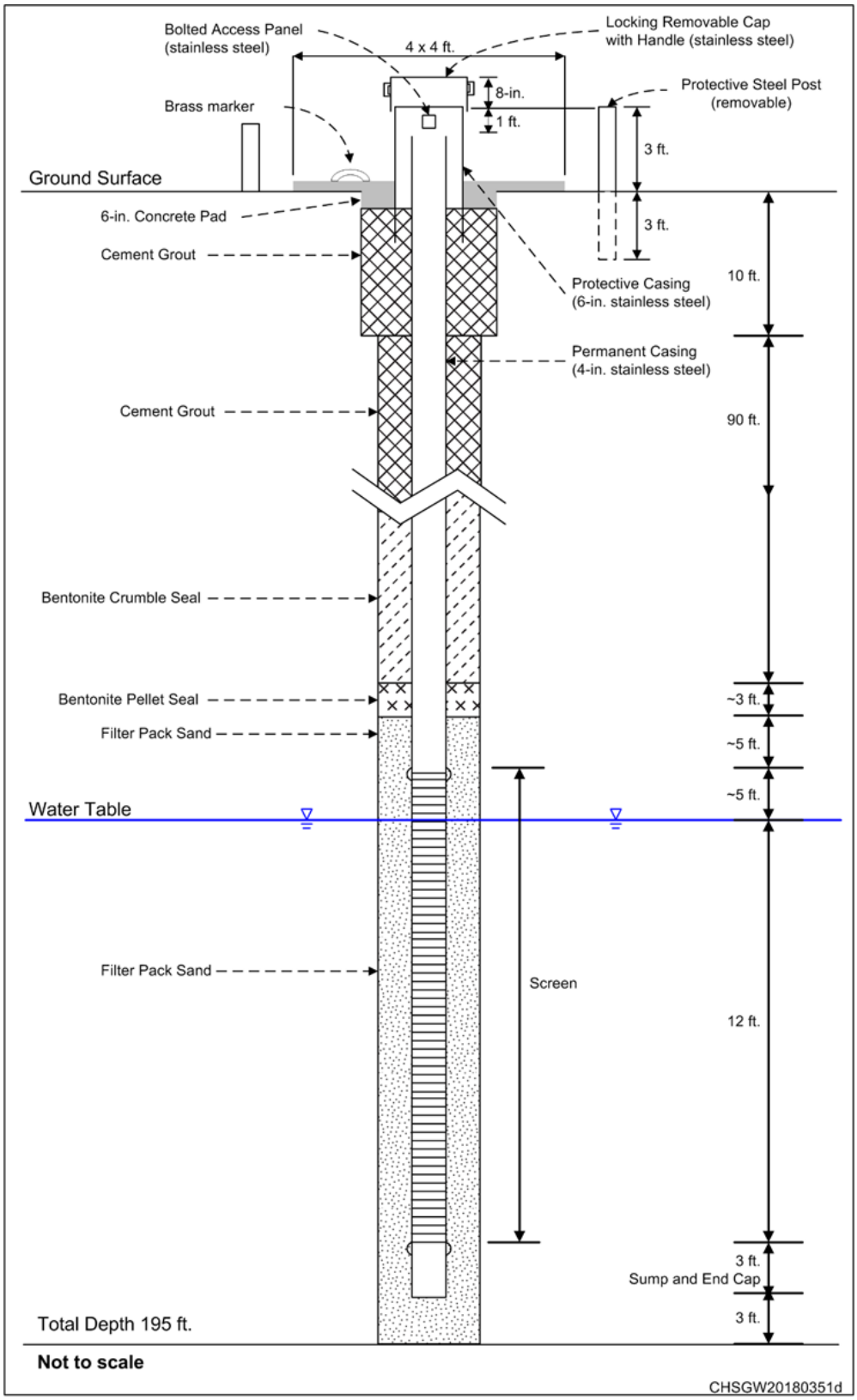


Figure 1-8. Preliminary Generic Design of Shallow Groundwater Monitoring Well

1.4.1 Geologic Soil Logging

Soil samples shall be logged throughout the borehole by the field geologist. The field geologist will collect drill cuttings every 1.5 m (5 ft) and at changes in lithology from surface-to-total depth for storage. Archive samples will be collected in pint-sized glass jars, and representative interval samples will be saved in chip trays. If representative samples cannot be collected, notes describing the condition of the samples will be entered into the field geologist's log. Archive samples will not be collected if contamination is encountered.

1.4.2 Radiological and Industrial Hygiene Field Screening

Field screening (radiological and industrial hygiene) will be performed by the radiological control technician, industrial hygiene technician, and other qualified personnel in accordance with approved methods and procedures. The radiological control and industrial hygiene technicians will record field measurements, noting the depth of the sample and the instrument reading on a radiological survey report. Field measurements will be communicated to the field geologist. The 216-B-3 Pond and WMA C are classified as contaminated waste sites based on historical releases. As such, continuous coverage will be required during drilling within the vadose zone to support characterization.

1.4.3 Geophysical Logging

All boreholes will be logged with the high-resolution spectral gamma logging system, and neutron moisture logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides, soil moisture variations, and borehole lithology changes. Neutron data will be converted from counts to volumetric moisture to provide quantitative moisture data in the vadose zone. The boreholes will be geophysically logged before downsizing each temporary casing string and/or once total drill depth is reached.

1.4.4 Well Development

The objectives of well development are to settle the filter pack, prevent uncontrolled infiltration of fines, and ensure communication of the well with the surrounding formation. Well development will be conducted during well construction and final development after the wells are completed. Initial development will be performed during well construction in conjunction with placement of the filter pack, with the use of a dual surge block to both settle the filter pack, and to develop communication across the borehole wall.

Final development is performed after well construction. Final well development with a submersible pump will occur after the fines are removed. If the well screen is >6.1 m (20 ft) in length, the development pump intake shall be placed at two equally spaced intervals along the length of the screen to develop the screened interval adequately.

During final well development, water samples will be screened in the field for analysis of turbidity, temperature, pH, and conductivity using field instruments. Development will continue until the well produces water <5 nephelometric turbidity units and the temperature, pH, and conductivity have stabilized (at least three consecutive measurements within 10% of each other).

Groundwater samples at wells 299-E27-40 and 299-E27-27 will be collected during the drilling process and prior to well development. A submersible pump will likely be used for sample collection. Groundwater samples at well 699-43-43B will be collected after well development with a low-flow, low purge volume pump.

This page intentionally left blank.

2 Quality Assurance Project Plan

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). DoD/DOE, 2017, *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (hereinafter called DOD/DOE QSM), is also discussed. Section 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b; hereinafter called the Tri-Party Agreement Action Plan) requires the QA/quality control (QC) and sampling and analysis activities to specify the QA requirements for Past-Practice Processes. This QAPjP also describes applicable requirements and controls based on guidance in Ecology Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans*. This QAPjP supplements the contractor's environmental QA program plan.

The QAPjP references are included in Chapter 6. The QAPjP includes the following sections, which describe the quality requirements and controls applicable to Hanford Site OU sampling activities:

- Section 2.1, "Project Management"
- Section 2.2, "Data Generation and Acquisition"
- Section 2.3, "Assessment and Oversight"
- Section 2.4, "Data Review and Usability"

2.1 Project Management

This section includes project organization and goals, planned approaches, and planned output documentation.

2.1.1 Project/Task Organization

The project organization is described in the following sections and illustrated in Figure 2-1.

2.1.1.1 Regulatory Agencies

The lead regulatory agency for the 200-BP-5 and 200-PO-1 OUs is Ecology. They are responsible for regulatory oversight of cleanup projects and activities. EPA retains approval authority for all SAPs. Ecology works with EPA and the DOE, Richland Operations Office (DOE-RL) to resolve concerns over the work described in this SAP in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

2.1.1.2 DOE-RL Manager

Hanford Site cleanup in the 200-BP-5 and 200-PO-1 OUs is the responsibility of DOE-RL. The DOE-RL Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under CERCLA, RCRA, *Atomic Energy Act of 1954*, and the Tri-Party Agreement (Ecology et al., 1989a).

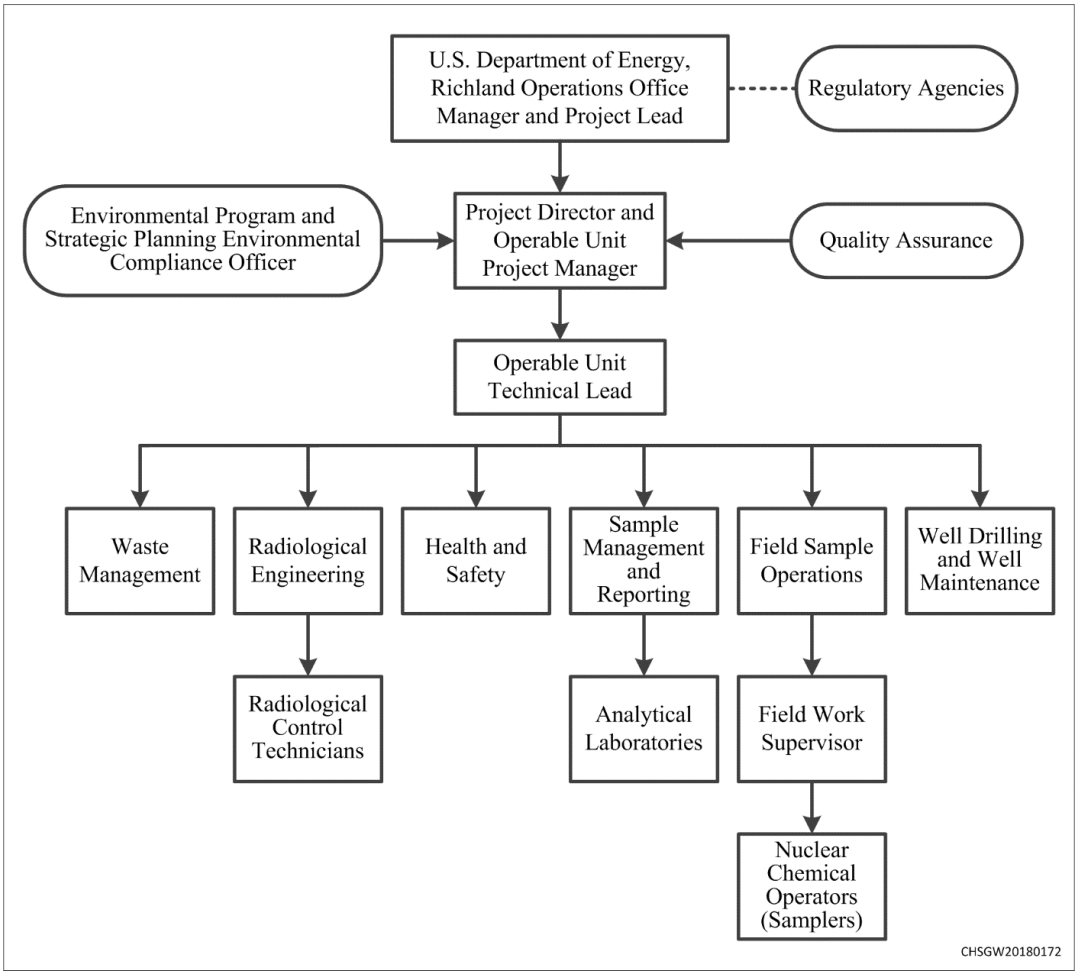


Figure 2-1. Project Organization

2.1.1.3 DOE-RL Project Lead

The DOE-RL Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE-RL management.

2.1.1.4 Soil and Groundwater Remediation Project Remedy Selection & Implementation Director

The Soil and Groundwater Remediation Project Remedy Selection & Implementation Director (i.e., Project Director in Figure 2-1) provides oversight and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The Soil and Groundwater Remediation Project Remedy Selection & Implementation Director also provides support to the OU Project Manager to ensure that work is performed safely and cost effectively.

2.1.1.5 Operable Unit Project Manager

The OU Project Manager (or designee) is responsible and accountable for the project-related activities including coordinating with DOE-RL, regulators, and contactor management in support of sampling activities to ensure work is performed safely and cost effectively. In addition, the OU Project Manager (or designee) is also responsible for managing sampling documents and requirements, field activities, subcontracted tasks, and for ensuring the project file is properly maintained.

2.1.1.6 Operable Unit Technical Lead

The OU Technical Lead is responsible for developing specific sampling design, analytical requirements, and QC requirements, either independently or as defined through a systematic planning process. The OU Technical Lead ensures that sampling and analysis activities, as delegated by the OU Project Manager, are carried out in accordance with the SAP and works closely with the Environmental Compliance Officer, QA, Health and Safety, the Field Work Supervisor (FWS), well drilling and planning, and the Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope.

2.1.1.7 Sample Management and Reporting

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the sample authorization form, which provides information and instruction to the analytical laboratories. The SMR group ensures that field sampling documents are revised to reflect approved changes. The SMR group receives analytical data from the laboratories, ensures it is appropriately reviewed, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. The SMR group is responsible for informing the OU Project Manager of any issues reported by the analytical laboratories.

2.1.1.8 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources. The FWS directs the nuclear chemical operators (samplers) who collect samples in accordance with this sampling plan and corresponding standard methods and work packages. The FWS ensures that deviations from field sampling documents or issues encountered in the field are documented appropriately (e.g., in the field logbook). The FWS ensures that samplers are appropriately trained and available. Samplers collect samples in accordance with sampling requirements. Samplers also complete field logbooks, data forms, and chain of custody forms, including any shipping paperwork, and enable delivery of the samples to the analytical laboratory.

Pre-job briefings are conducted by FSO, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering the following factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required

2.1.1.9 Quality Assurance

The QA point of contact provides independent oversight and is responsible for addressing QA issues on the project, overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents including the QAPjP and participating in QA assessments on sample collection and analysis activities, as appropriate.

2.1.1.10 Environmental Compliance Officer

The Environmental Compliance Officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

2.1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or internal primary contractor work requirements.

2.1.1.12 Radiological Engineering

Radiological Engineering is responsible for the following:

- Radiological engineering and project health physics support
- Conducting as low as reasonably achievable reviews, exposure and release modeling, and radiological controls optimization
- Identifying radiological hazards and ensuring appropriate controls are implemented to maintain worker exposures to hazards at as low as reasonably achievable levels
- Interfacing with the project Health and Safety representative and other appropriate personnel, as needed, to plan and direct project radiological control technician (RCT) support

2.1.1.13 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance and for interpreting data to determine waste designations and profiles. Waste Management communicates policies and practices and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

2.1.1.14 Analytical Laboratories

The analytical laboratories analyze samples in accordance with established methods and the requirements of their subcontract and provide necessary data packages containing analytical and QC results. Laboratories provide explanations of results to support data review and in response to resolution of analytical issues. Laboratory quality requirements are consistent with the HASQARD (DOE/RL-98-68). The laboratories are evaluated under the DOE Consolidated Audit-Accreditation Program or its successor programs to DoD/DOE QSM (DoD/DOE, 2017) requirements. HASQARD requirements, beyond those within the DoD/DOE QSM, are also evaluated under the DOE Consolidated Audit-Accreditation Program. Laboratories are accredited by Ecology for the analyses performed under this SAP.

2.1.1.15 Well Drilling and Well Maintenance

The well drilling and maintenance and well coordination planning managers are responsible for the following:

- Planning, coordinating, and executing drilling construction
- Well maintenance activities
- Coordinating with the OU Technical Lead about field constraints that could affect sampling design

- Coordinating well decommissioning with DOE-RL and Ecology approval, as appropriate in accordance with WAC 173-160.

2.1.2 Quality Objectives and Criteria

The QA objective of this plan is to ensure the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the sampling plan. Data descriptors known as data quality indicators (DQIs) help determine the acceptability and usefulness of data to the user. The principal DQIs (precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity) are defined for the purposes of this document in Table 2-1.

Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during a process to assess data usability (Section 2.4.3).

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or re-measurement. • Qualify the data before use.
Accuracy (laboratory control samples, matrix spikes, surrogates, tracers)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for results not being representative. • Flag for further review. • Review data for usability. • If data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.
Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Completeness (no QC element; addressed in data quality assessment)	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If data set does not meet the completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.
Bias (equipment blanks, full trip blanks, field transfer blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling practices to limit preferential selection or loss of sample media. • Use sample handling practices, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other laboratories for analysis.

Table 2-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI.*

a. Acceptance criteria for QC elements are provided in Table 2-5.

b. For purposes of this sampling plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QA = quality assurance

QC = quality control

2.1.3 Method-Based Analysis

Laboratory testing and reporting for the analytes described in Section 2.2.1 may include nontarget analytes that are part of the analytical method (i.e., methods-based reporting). The nontarget analyte results reported by the laboratory as part of the method will be considered with those for the target analyte list (Tables 1-2 and 1-3) and used to supplement expected future data collection activities. Analytical performance requirements will be applicable to all analytes resulting from the method-based analysis process including nondetects flagged as such by the laboratory.

2.1.4 Analytical Priority

If sample volume is insufficient to analyze for all analytes listed for a given sample interval, the highest priority analytes critical for supporting characterization are required to be analyzed with each discrete sample interval. Sample priority is defined in Tables 1-2 and 1-3. Uncollected soil samples for chemical and radiological analysis shall be collected from the succeeding sample interval where possible. Otherwise, additional split spoons shall be driven if sample volumes are not sufficient.

2.1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting samples and compliant with applicable DOE orders and government regulations. The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training has been instituted by the contractor management team to meet training and qualification programs that satisfy multiple training drivers imposed by applicable DOE, *Code of Federal Regulations*, and *Washington Administrative Code* requirements.

Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up to date prior to performing fieldwork.

2.1.6 Documentation and Records

The OU Project Manager (or designee) is responsible for ensuring the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Table 2-2 defines the types of changes that may impact the sampling and the associated approvals, notifications, and documentation requirements.

Table 2-2. Change Control for Sampling Projects

Type of Change[a]	Action	Documentation
Minor Field Change. Changes that have no adverse effect on the technical adequacy of the sampling activity or the work schedule.	The field personnel recognizing the need for a field change will consult with the OU Project Manager (or designee) prior to implementing the field change.	Minor field changes will be documented in the field logbook. The logbook entry will include the field change, the reason for the field change, and the names and titles of those approving the field change.
Minor Change. Changes to approved plans that do not affect the overall intent of the plan or schedule.	The OU Project Manager will inform DOE-RL and the Regulatory Lead of the change. The lead regulatory agency and EPA determine if there is a need to revise the document.	Documentation of this change approval would be in the Project Manager's Meeting Minutes and comparable Tri-Party Agreement Change Notice[b].
Revision Necessary. Lead regulatory agency determines if changes to approved plans require revision to document.	If it is anticipated that a revision is necessary, the OU Project Manager will inform DOE-RL and the Regulatory Lead. The lead regulatory agency and EPA determine if the change requires a revision to the document.	Formal revision of the sampling document.

References: DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*.

Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement).

Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*.

a. Consistent with DOE/RL-96-68 *et seq* Sections 9.3 and 12.4 of Ecology et al., 1989b.

b. The Tri-Party Agreement Action Plan, Section 9.3, defines the minimum elements of a change notice.

DOE-RL = U.S. Department of Energy, Richland Operations Office

EPA = U.S. Environmental Protection Agency

OU = operable unit

Logbooks are required for sampling field activities. The logbook must be identified with a unique project name and number. Only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes. Data forms are also required for field activities and shall be controlled in accordance with internal work requirements and processes.

The FWS and SMR are responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The SMR will ensure that any deviations from the SAP are reflected in revised field sampling documents for the samplers and the analytical laboratory.

The FWS will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook).

The OU Project Manager, FWS, or designee, is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The OU Project Manager is also responsible for ensuring that project files are appropriately set up and maintained. The project files will contain project records or references to their storage locations. Project files may include the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to SMR)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports
- Photographs

The following records are managed and maintained by SMR personnel:

- Completed field sampling logbooks
- Field and analytical data
- Completed chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by the offsite analytical laboratories

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hard copy format (e.g., DOE Records Holding Area). Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed per Tri-Party Agreement requirements.

2.2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling measurement and analysis, data collection and generation, data handling, and QA/QC activities are appropriate and documented. Requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

2.2.1 Analytical Methods Requirements

Table 2-3 provides information regarding analytical method requirements for samples collected. Updated EPA methods and nationally recognized standard methods may be substituted for the analytical methods identified in Table 2-3 in order to follow changed requirements in the method update. The new method shall achieve project DQOs as well or better than the replaced method.

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS#	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
General Chemical Parameters				
Alkalinity	ALKALINITY	310.1 or Standard Method 2320	5,250	NA
pH[b]	PH	150.1	NA	NA
Specific Conductance[b]	NA	9050	NA	NA
Ammonia and Anions[b]				
Bromide	24959-67-9	300 or 9056	262.5	12,500
Chloride	16887-00-6	300 or 9056	400	55,000
Fluoride	16984-48-8	300 or 9056	525	25,000
Nitrate	14797-55-8	300 or 9056	250	12,500
Nitrite	14797-65-0	300 or 9056	250	12,500
Phosphate	14265-44-2	300 or 9056	525	5,000
Sulfate	14808-79-8	300 or 9056	1,050	27,500
Sulfide	18496-25-8	376.1 or Standard Method 4500S for water, 9034 for soil	2,100	25,000
Ammonia	7664-41-7	350.1	105	500
Metals[b]				
Aluminum	7429-90-5	6020 for water, 6010 for soil	105	20,000
Antimony	7440-36-0	6020 for water, 6010 for soil	5.25	1,200
Arsenic	7440-38-2	6020	10.5	1,000
Barium	7440-39-3	6020	5.25	2,000
Beryllium	7440-41-7	6020	1.05	200
Boron	7440-42-8	6010	105	5,000

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS#	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
Cadmium	7440-43-9	6020	2.1	200
Calcium	7440-70-2	6010	1,050	100,000
Chromium	7440-47-3	6020	10.5	1,000
Cobalt	7440-48-4	6020	5.25	400
Copper	7440-50-8	6020	12.6	1,000
Iron	7439-89-6	6010	105	25,000
Lead	7439-92-1	6020	3.15	300
Magnesium	7439-95-4	6010	1050	100,000
Manganese	7439-96-5	6020	5.25	1,000
Molybdenum	7439-98-7	6020	5.25	500
Nickel	7440-02-0	6020	21	500
Phosphorus	7723-14-0	6010	262.5	50,000
Potassium	7440-09-7	6010	5,250	500,000
Selenium	7782-49-2	6020	10.5	500
Silver	7440-22-4	6020 for water, 6010 for soil	5.25	1,000
Sodium	7440-23-5	6010 for water, 6020 for soil	1,050	100,000
Strontium (elemental)	7440-24-6	6020	10.5	500
Thallium	7440-28-0	6020	2.1	500
Thorium	7440-29-1	6020	5.25	200
Tin	7440-31-5	6020	10.5	500
Uranium	7440-61-1	6020	1.05	150
Vanadium	7440-62-2	6010	52.5	5,000
Zinc	7440-66-6	6010	21	5,000
Cyanide (Total)	57-12-5	9012 or 9014 or 335.4 or 4500	NA	1,000
Free cyanide	FREE-CN	9014	4	NA
Mercury	7439-97-6	7470 for water, 7471 for soil	0.5	200

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS#	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
Polychlorinated Biphenyls				
Aroclor-1016	12674-11-2	8082	1.05	333
Aroclor-1221	11104-28-2	8082	2.1	33
Aroclor-1232	11141-16-5	8082	1.05	33
Aroclor-1242	53469-21-9	8082	1.05	33
Aroclor-1248	12672-29-6	8082	1.05	33
Aroclor-1254	11097-69-1	8082	1.05	33
Aroclor-1260	11096-82-5	8082	1.05	33
Aroclor-1262	37324-23-5	8082	1.05	33
Aroclor-1268	11100-14-4	8082	1.05	33
Volatile Organics				
2-Butanone	78-93-3	8260	10.5	20
4-Methyl-2-Pentanone	108-10-1	8060	10.5	20
Acetone	67-64-1	8060	20	20
(m+p)-Xylene	179601-23-1	8060	5	5
o-Xylene	95-47-6	8060	5	5
Trichloroethene	79-01-6	8060	2.1	5
Semivolatile Organics				
Tributyl phosphate	126-73-8	8270	10.5	333
Total organic carbon	TOC	415.1 or 9060	1050	100,000
Constituent/Parameter	**CAS#**	**Analytical Method[a]**	**PQL for Water (pCi/L)**	**PQL for Soil (pCi/g)**
Radionuclides				
Americium-241	14596-10-2	Alpha energy analysis	1	1
Antimony-125	14234-35-6	Low-energy gamma or gas proportional counting	50	0.3
Carbon-14	14762-75-5	Liquid scintillation counter	50	5
Cesium-137	10045-97-3	Gamma energy analysis	15	0.1
Cobalt-60	10198-40-0	Gamma energy analysis	25	0.1

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS#	Analytical Method[a]	PQL for Water (pCi/L)	PQL for Soil (pCi/g)
Radionuclides				
Curium-244	13981-15-2	Alpha energy analysis	1	1
Europium-152	14683-23-9	Gamma energy analysis	50	0.1
Europium-154	15585-10-1	Gamma energy analysis	50	0.1
Europium-155	14391-16-3	Gamma energy analysis	50	0.1
Iodine-129	15046-84-1	Low-energy gamma or gas proportional counting	5	2
Neptunium-237	13994-20-2	Alpha energy analysis	1	1
Nickel-63	13981-37-8	Liquid scintillation counter	50	10
Plutonium-241	14119-32-5	Alpha energy analysis	25	15
Plutonium-238	13981-16-3	Alpha energy analysis	1	1
Plutonium-239/240	PU-239/240	Alpha energy analysis	1	1
Selenium-79	15758-45-9	Liquid scintillation counter	50	10
Strontium-90	10098-97-2	Low-energy gamma or gas proportional counting	2	2
Technetium-99[b]	14133-76-7	Liquid scintillation counter	50	5
Thorium-228	14274-82-9	Alpha energy analysis	1	1
Thorium-230	14269-63-7	Alpha energy analysis	1	1
Thorium-232	TH-232	Alpha energy analysis	1	1
Tritium	10028-17-8	Liquid scintillation counter	700	30
Uranium-235/236	15117-96-1	Alpha energy analysis	1	1
Uranium-238	U-238	Alpha energy analysis	1	1
Geotechnical Soil Properties				
Unsaturated hydraulic conductivity	NA	PNNL Analysis[c]	NA	NA
Saturated hydraulic conductivity	NA	PNNL Analysis[c]	NA	NA

Table 2-3. Performance Requirements for Soil and Water Analysis

Constituent/Parameter	CAS#	Analytical Method[a]	PQL for Water (µg/L)	PQL for Soil (µg/kg)
Matric potential using filter paper	NA	PNNL Analysis[c]	NA	NA
Grain size distribution	NA	PNNL Analysis[c]	NA	NA
Gravimetric moisture content	NA	PNNL Analysis[c]/ASTM D2216	NA	NA
Bulk density	NA	PNNL Analysis[c]	NA	NA
Total porosity	NA	PNNL Analysis[c]	NA	NA
Field Screening				
Radiological screening by radiological control technician	NA	Field measurement instrument/meter	NA	NA
Dissolved oxygen	NA	Field measurement instrument/meter	NA	NA
Oxidation-reduction potential	NA	Field measurement instrument/meter	NA	NA
pH	NA	Field measurement instrument/meter	NA	NA
Specific conductivity	NA	Field measurement instrument/meter	NA	NA
Temperature	NA	Field measurement instrument/meter	NA	NA
Turbidity	NA	Field measurement instrument/meter	NA	NA

References: APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*.

ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Waste*.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI*.

Note: Analytical methods and practical quantitation limits provided in this table do not represent EPA requirements but are intended solely as guidance.

a. For EPA Method 300.0 and 335.4, see EPA/600/R-93/100. For EPA Methods 150.1, 310.1, 350.1, 376.1 and 415.1, see EPA-600/4-79-020. For four-digit EPA methods, see SW-846. For Standard Methods, see APHA/AWWA/WEF, 2012. Equivalent methods may be substituted.

b. In addition to the inductively coupled plasma metals, anions, technetium-99, cyanide, water, and soil samples listed in this table, vadose zone extraction of water will also be performed on soil samples at the laboratory. The water extraction (at 1:1 sediment/water ratio) is the aqueous contaminant fraction extracted in the deionized water with a 1-hour sediment contact time. pH and specific conductance shall also be performed on the extract.

Table 2-3. Performance Requirements for Soil and Water Analysis

c. Geotechnical soil property samples >30.5 m (100 ft) below groundwater surface will be collected for WRPS. The samples will be transported to PNNL and analyzed for the parameters above according to RPP-PLAN-63020, *Sampling and Analysis Plan for WMA A-AX Focus Area 2 (Southwestern Area of A Farm)*, ASTM D2216, and ASTM D5298-16, *Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper*.

CAS	=	Chemical Abstracts Service	PNNL	=	Pacific Northwest National Laboratory
EPA	=	U.S. Environmental Protection Agency	PQL	=	practical quantitation limit
NA	=	not applicable	WRPS	=	Washington River Protection Solutions

2.2.2 Field Analytical Methods

Field screening and survey data will be measured consistent with HASQARD (DOE/RL-96-68). Field analytical methods are performed in accordance with the manufacturers' manuals. Table 2-3 provides the parameters for field measurements.

2.2.3 Quality Control Requirements

The QC requirements specified in the SAP must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC samples are summarized in Table 2-4. Acceptance criteria for field and laboratory QC are shown in Table 2-5. Data will be qualified and flagged in HEIS, as appropriate.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA sanctioned Water Pollution and Water Supply Performance Evaluation studies. Audit results are used to improve performance.

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Equipment blank	Contamination from nondedicated sampling equipment	1 per 20 samples
Full trip blank	Contamination from containers, preservative reagents, storage, or transportation	1 per 20 samples
Field transfer blank	Contamination from sampling site	1 per day when VOCs are sampled; additional field transfer blanks are collected if VOC samples are acquired on the same day for multiple laboratories (wells or other media samples)
Field duplicate samples	Reproducibility/sampling precision	1 in 20 samples
Field split samples	Inter-laboratory comparability	1 per 20 samples

Table 2-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Laboratory Batch Quality Control[a]		
Carrier	Recovery/yield	Added to each sample and quality control sample[b]
Method blanks	Laboratory contamination	1 per analytical batch[b]
Laboratory sample duplicate	Laboratory reproducibility and precision	1 per analytical batch[b]
Matrix spikes	Matrix effect/laboratory accuracy	1 per analytical batch[b]
Matrix spike duplicate	Laboratory reproducibility, and method accuracy and precision	1 per analytical batch[b]
Surrogates	Recovery/yield for organic compounds	Added to each sample and quality control
Tracers	Recovery/yield	Added to each sample and quality control
Laboratory control	Method accuracy	1 per analytical batch[b]

Note: The information in this table does not represent U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

b. Unless not required by, or different frequency is called out, in laboratory analysis method.

VOC = volatile organic compound

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
General Chemical Parameters				
Alkalinity	MB	<MDL <5% sample concentration		Flag with “C”
	LCS	80%-120% recovery		Flag with “o”[a]
	DUP[b] or MS/MSD [c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with “N”
	EB, FTB	<MDL <5% sample concentration		Flag with “Q”
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
pH	LCS	80%-120% recovery		Flag with “o”[a]
	DUP	≤20% RPD	≤35% RPD	Review data [d]
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Specific conductance	LCS	80%-120% recovery		Flag with "o"[a]
	DUP	≤20% RPD	≤20% RPD	Review data[d]
	Field Duplicate[b]	≤20% RPD	≤20% RPD	Review data[d]
Ammonia and Anions				
Ammonia	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Anions by IC and Sulfide	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o" [a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Cyanide (Total)/Cyanide (Free)	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with "N"
	EB, FTB	<MDL < 5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Metals				
ICP-AES and ICP-MS Metals	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD [c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD[c]	75%-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Mercury by Cold-Vapor Atomic Absorption	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD [c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD [c]	75-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Volatile Organic Compounds				
Volatile Organics by GC-MS	MB	<MDL[g] <5% sample concentration		Flag with "B"
	LCS	70%-130% recovery or % recovery statistically derived [f]		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD		Review data[d]
	MS/MSD[c]	70%-130% recovery		Flag with "T"
	SUR	70%-130% recovery	% recovery statistically derived[f]	Review data[d]
	EB, FTB, FXR	<MDL[g] <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Semivolatile Organic Compounds and PCBs				
PCBs by GC	MB	<MDL <5% sample concentration		Flag with "B"
	LCS	70%-130% recovery or % recovery statistically derived[f]		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤30% RPD	Review data[d]
	MS/MSD[c]	% recovery statistically derived[f]		Flag with "N"
	SUR	% recovery statistically derived[f]	% recovery statistically derived[f]	Review data[d]
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Semivolatile Organics by GC-MS	MB	<MDL[g] <5% sample concentration		Flag with "B"
	LCS	70%-130% recovery or % recovery statistically derived [f]		Flag with "o"[a]
	DUP[b] or MS/MSD[c]	≤20% RPD	≤30% RPD	Review data[d]
	MS/MSD[c]	% recovery statistically derived[f]		Flag with "T"
	SUR	% recovery statistically derived[f]	% recovery statistically derived[f]	Review data[d]
	EB, FTB	<MDL[g] <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Total Organic Carbon	MB	<MDL <5% sample concentration		Flag with "C"
	LCS	80%-120% recovery		Flag with "o"[a]
	DUP[b] or MS/MSD [c]	≤20% RPD	≤35% RPD	Review data[d]
	MS/MSD [c]	75%-125% recovery		Flag with "N"
	EB, FTB	<MDL <5% sample concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Radiological Parameters				
AEA (Neptunium, Thorium, Uranium, Plutonium, Americium, and Curium Isotopics)	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits[f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	Tracer	30%-105% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Carbon-14	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits [f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%-125% recovery		Flag with "N"
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
GEA (Cesium, Cobalt, Europium Isotopics)	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits [f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Iodine-129, Antimony-125	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits [f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	Carrier	40%-110% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Nickel-63	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits [f]		Flag with "o"[a]
	DUP [b]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%-125% recovery		Review data[d]
	Carrier	40%-110% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Selenium-79	MB	<MDC < 5% sample activity concentration		Flag with "B"
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	Carrier	40%-110% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	
Strontium-90	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits [f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	Tracer	30%-105% recovery		Review data[d]
	Carrier	40%-110% recovery		Review data[d]
	EB, FTB	<MDC <5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Technetium-99	MB	<MDC <5 % sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limits[f]		Flag with "o"[a]
	DUB[b]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%-125% recovery		Flag with "N"
	EB, FTB	<MDC 5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]
Tritium	MB	<MDC <5% sample activity concentration		Flag with "B"
	LCS	80%-120% recovery or statistically derived limit[f]		Flag with "o"[a]
	DUP[b]	≤20% RPD	≤30% RPD	Review data[d]
	MS	75%-125% recovery		Flag with "N"
	EB, ETB	<MDC 5% sample activity concentration		Flag with "Q"
	Field Duplicate[b]	≤20% RPD	--[e]	Review data[d]

Notes: The information in this table does not represent EPA requirements and is intended solely as guidance.

See Table 2-3 for constituent list and analytical methods.

a. The reporting laboratory will apply the "o" flag with SMR organization concurrence.

b. Applies when at least one result is greater than the laboratory PQL (chemical analyses) or greater than five times the MDC (radiochemical analyses).

c. Either a DUP or MS/MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, an LCSD is analyzed with the acceptance criteria defaulting to the <20% RPD criteria [water] or <30% RPD criteria [soil]).

Table 2-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Analyte	QC Element	Acceptance Criteria		Corrective Action
		Water	Soil	

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.

e. A field duplicate RPD for soils is not recommended because of possible soil matrix heterogeneity effects.

f. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

g. For the common laboratory contaminants acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criterion is less than five times the MDL.

Data Flags:

B, C	=	possible laboratory contamination: analyte was detected in the associated method blank – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.
o	=	result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied.
N	=	result may be biased: associated matrix spike result was outside the acceptance limits (except GC-MS) – laboratory applied.
T	=	result may be biased: associated matrix spike result was outside the acceptance limits (GC-MS only) – laboratory applied.
Q	=	problem with associated field QC blank: results were out of limits – SMR review.

AEA	=	*Atomic Energy Act of 1954*	LCS	=	laboratory control sample
DUP	=	laboratory sample duplicate	LCSD	=	laboratory control sample duplicate
EB	=	equipment blank	MB	=	method blank
EPA	=	U.S. Environmental Protection Agency	MDC	=	minimum detectable concentration
FTB	=	full trip blank	MDL	=	method detection limit
FXR	=	field transfer blank	MS	=	matrix spike
GC	=	gas chromatography	MSD	=	matrix spike duplicate
GC-MS	=	gas chromatograph-mass spectrometry	PCB	=	polychlorinated biphenyls
GEA	=	gamma energy analysis	PQL	=	practical quantitation limit
IC	=	ion chromatography	QC	=	quality control
ICP-AES	=	inductively coupled plasma-atomic emission spectroscopy	RPD	=	relative percent difference
			SUR	=	surrogate
ICP-MS	=	inductively coupled plasma-mass spectrometry	SMR	=	Sample Management and Reporting

2.2.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure reliable data are obtained. Field QC samples include field duplicates, field split (SPLIT) samples, and three types of field blanks (equipment blanks, full trip blanks [FTBs], and field transfer blanks [FXRs]). High-purity deionized water[1] is the preferred blank matrix when water-based samples are collected, and silica sand is typically used for the field blank when soil or other solid samples are acquired. QC sample definitions and their required frequency for collection are described in the following paragraphs.

[1] Reagent water is high-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

Field duplicates: Independent samples collected as close as possible to the same time and same location as the schedule sample and intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.

Field splits: Two samples collected as close as possible to the same time and same location and intended to be identical. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.

Equipment blanks: High-purity water or silica sand as appropriate are passed through or poured over decontaminated sampling equipment identical to the sample set collected and placed in sample containers, as identified on the sample authorization form. Equipment blank sample bottles are placed in the storage containers with samples from the associated sampling event and are analyzed for the same constituents as samples from the sampling event. Equipment blanks are used to evaluate decontamination process effectiveness; these samples are not required for disposable sampling equipment.

Full trip blanks: Bottles prepared by the sampling team before travel to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with high-purity water or silica sand as appropriate and the bottles are sealed and transported (unopened) to the field in the same storage containers used for samples collected that day. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential sample contamination from the sample bottles, preservative, handling, storage, and transportation.

Field transfer blanks: FXRs are used to document possible contamination during field acquisition of volatile organic compound samples. FXRs are sample bottles (already containing any required sample preservative) filled at the sample collection site with high-purity deionized water or silica sand as appropriate. The blank is sealed at the sampling site and becomes part of the sample set sent to the laboratory.

2.2.3.2 Laboratory QC Samples

Internal QA/QC programs are maintained by laboratories used by the project. Laboratory QA includes a comprehensive QC program that includes the use of laboratory control samples, laboratory sample duplicates, matrix spikes (MSs), matrix spike duplicates (MSDs), and method blanks (MBs). These QC analyses are required by EPA methods (e.g., those in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI*), and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during assessments of data usability, if performed. Laboratory QC checks and their typical frequencies are listed in Table 2-4. Acceptance criteria are shown in Table 2-5. Descriptions of the various types of laboratory QC samples are provided in the following paragraphs.

Carrier: A known quantity of nonradioactive isotope that is expected to behave similarly and is added to an aliquot of sample. Sample results are generally corrected based on carrier recovery.

Laboratory control sample: A control matrix (e.g., reagent water) spiked with analytes representing the target analytes or certified reference material used to evaluate laboratory accuracy.

Laboratory sample duplicate: An intra-laboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.

Matrix spike: An aliquot of a sample spiked with a known concentration of target analyte(s). The matrix spike is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.

Matrix spike duplicate: A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. Matrix spike duplicate results are used to determine the bias and precision of a method in a given sample matrix.

Method blank: An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the sample preparations and analytical procedure and is used to quantify contamination resulting from the analytical process.

Surrogate (SUR): A compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and measurement systems in a manner similar to the analytes of interest. Because SURs are added to every standard, sample, and QC sample, they are used to evaluate overall method performance in a given matrix. SURs are used only in organic analyses.

Tracer: A known quantity of radioactive isotope that is different from that of the isotope of interest but is expected to behave similarly and is generally added to an aliquot of sample prior to the sample preparation step. A tracer does not chemically interfere with the target radioisotope during radiochemical preparation, separation, and counting. Sample results are generally corrected based on tracer recovery.

Laboratories are required to analyze samples within the holding times specified in Table 2-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or by other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an “H.”

2.2.4 Measurement Equipment

Each measuring equipment user is responsible to ensure the equipment is functioning as expected, properly handled, and properly calibrated at required frequencies per methods governing control of the equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer’s specifications and other approved methods.

2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization’s QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with HASQARD (DOE/RL-98-68) requirements.

Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes

Constituent/ Parameter[a]	Preservation[b]		Holding Time	
	Water	Soil	Water	Soil
Anions, Metal, Alkalinity, pH				
Alkalinity	Store ≤6°C	Store ≤6°C	14 days	14 days
Ammonia	H_2SO_4 to pH <2; ≤6°C	Store ≤6°C	28 days	28 days
Bromide, Chloride, Fluoride, and Sulfate	Store ≤6°C	Store ≤6°C	28 days	28 days before extraction/ 28 days after extraction
Nitrate, Nitrite, and Phosphate	Store ≤6°C	Store ≤6°C	48 hours	28 days before extraction/ 28 days after extraction
Metals	HNO_3 to pH<2	None	6 months	6 months
Specific Conductance	Store ≤6°C	Not applicable	28 days	Not applicable
Mercury	HNO_3 to pH<2	None	28 days	28 days
Cyanide	Not applicable	Store ≤6°C	NA	14 days before/14 days after extraction
Free Cyanide	NaOH to pH >12	Not applicable	14 days	Not applicable
pH	None	None	None	None
Sulfide	ZnAc+NAOH to pH >9; ≤6°C	Store ≤6°C	7 days	7 days
Organics				
Volatile Organics	HCl or H_2SO_4 to pH <2; ≤6°C	Store ≤6°C	14 days	14 days
Semivolatile Organics	Store ≤6°C	Store ≤6°C	7 days before extraction/ 40 days after extraction	14 days before extraction/ 40 days after extraction
Total Organic Carbon	HCL or H_2SO_4 to pH<2;	Store ≤6°C	28 days	28 days
Polychlorinated Biphenyl				
Polychlorinated biphenyl	Store ≤6°C	Store ≤6°C	1 year before extraction/ 40 days after extraction	1 year before extraction/ 40 days after extraction

Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes

Constituent/ Parameter[a]	Preservation[b]		Holding Time	
	Water	Soil	Water	Soil
Radionuclides				
Americium-241	HNO_3 to pH<2	None	6 months	6 months
Antimony-125	HNO_3 to pH<2	None	6 months	6 months
Carbon-14	None	None	6 months	6 months
Cesium-137	HNO_3 to pH<2	None	6 months	6 months
Cobalt-60	HNO_3 to pH<2	None	6 months	6 months
Curium-244	HNO_3 to pH<2	None	6 months	6 months
Europium-152	HNO_3 to pH<2	None	6 months	6 months
Europium-154	HNO_3 to pH<2	None	6 months	6 months
Europium-155	HNO_3 to pH<2	None	6 months	6 months
Iodine-129	None	None	6 months	6 months
Neptunium-237	HNO_3 to pH<2	None	6 months	6 months
Nickel-63	None	None	6 months	6 months
Plutonium-238	HNO_3 to pH<2	None	6 months	6 months
Plutonium-239/240, 241	HNO_3 to pH<2	None	6 months	6 months
Selenium-79	HNO_3 to pH<2	None	6 months	6 months
Strontium-90	HNO_3 to pH<2	None	6 months	6 months
Technetium-99	HNO_3 to pH<2	None	6 months	6 months
Thorium-228	HNO_3 to pH<2	None	6 months	6 months
Thorium-230	HNO_3 to pH<2	None	6 months	6 months
Thorium-232	HNO_3 to pH<2	None	6 months	6 months
Tritium	None	None	6 months	6 months
Uranium-235/236	HNO_3 to pH<2	None	6 months	6 months
Uranium-238	HNO_3 to pH<2	None	6 months	6 months
Geotechnical Test Methods				
Unsaturated hydraulic conductivity	None		Analyze as soon as possible after collection	
Saturated hydraulic conductivity	None		Analyze as soon as possible after collection	

Table 2-6. Holding Time and Preservation Guidelines for Laboratory Analytes

Constituent/ Parameter[a]	Preservation[b]		Holding Time	
	Water	Soil	Water	Soil
Matrix potential using filter paper	None		Analyze as soon as possible after collection	
Grain size distribution	None		None	
Gravimetric moisture content	Store ≤6°C		14 days	
Bulk density	None		Not applicable	
Porosity	None		Not applicable	

Notes: Holding times and preservation methods are dependent of the constituents and are consistent with EPA guidance and approved analytical methods. The information in this table does not represent EPA requirements but is intended solely as guidance.

Container types and volumes are available on chain-of-custody documentation.

a. See Table 2-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

2.2.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Section 3.5. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

2.2.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

2.2.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical databases will be technically reviewed to the same extent as data generated as part of any sampling and analysis QA/QC effort. Data used in evaluations will be identified by data source.

2.2.9 Data Management

The SMR group, in coordination with the OU Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management methods.

Electronic analytical data will be accessed through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group through an established process. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and to establish their resolution with the OU Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

2.3 Assessment and Oversight

Assessment and oversight activities address the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Action

Management assessments and/or independent assessments may be performed to verify compliance with the requirements outlined in this SAP, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project line management chain coordinates the corrective actions/deficiency resolutions in accordance with the QA program, the corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the OU Project Manager (or designee). An assessment of data usability will be performed for the identified SAP activities. Results of the assessment will be provided to the OU Project Manager. No other planned assessments have been identified. If circumstances arise in the field dictating the need for additional assessments, then additional assessments will be performed.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The SMR group oversees offsite analytical laboratories and verifies the laboratories are qualified to perform Hanford Site analytical work.

2.3.2 Reports to Management

Program and project management (as appropriate) will be made aware of deficiencies identified by assessment and oversight. Issues reported by the laboratories are communicated to the SMR group, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and to establish resolution with the OU Project Manager. If an assessment finding results in sampling issues that affect a regulatory requirement, DOE will be informed and the matter discussed with the regulatory agencies.

2.4 Data Review and Usability

This section addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus, satisfying the project objectives.

2.4.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times, if any, have been met. Furthermore, review of QC data is used to determine whether analyses have met the data quality requirements specified in this SAP.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results will be reviewed to ensure they are usable.

The OU Technical Lead performs data reviews to help determine if observed changes reflect potential data errors, which may result in submitting a request for data review on questionable data. The laboratory may be asked to check calculations or reanalyze the sample. In extreme cases, another sample may be collected. Results of the request for the data review process are used to flag the data appropriately in the HEIS database and/or to add comments.

2.4.2 Data Validation

Data validation is an independent assessment to ensure the reliability of the data. Analytical data validation provides a level of assurance that an analyte is present or absent. Validation may also include the following:

- Verification of instrument calibrations
- Evaluation of analytical results based on MBs
- Recovery of various internal standards
- Correctness of uncertainty calculations
- Correctness of identification and quantification of analytes
- The effect of quality deficiencies on data reliability

The contractor follows the data validation process described in EPA-540-R-2017-001, *National Functional Guidelines for Inorganic Superfund Methods Data Review*; and EPA-540-R-2017-002, *National Functional Guidelines for Organic Superfund Methods Data Review*, adjusted for use with SW-846, HASQARD (DOE/RL-96-68), and radiochemistry methods. The criteria for data validation are based on a graded approach, using five levels of validation: Levels A through E. Level A is the lowest level and is the same as verification. Level E is a 100% review of all data (e.g., calibration data and calculations of representative samples from the data set). Data validation will be performed to Level C, which is a review of the QC data. Level C validation consists of a review of the QC data and specifically requires verification of deliverables; requested versus reported analytes; and qualification of the results based on evaluation of analytical holding times, MB results, MS/MSD results, surrogate recoveries, and duplicate sample results. Level C data validation is generally equivalent to Level 2A in EPA 540-R-08-005, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. Level C data validation will be performed on at least 5% of the data by matrix and analyte group under the direction of SMR. Analyte group refers to categories such as radionuclides, volatile chemicals, semivolatiles, metals, and anions. The goal is to include each of the various analyte groups and matrices during the data validation process. The DOE-RL Project Lead or OU Project Manager may specify a higher percentage of data to be validated or that data validation be performed at higher levels.

2.4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The data quality assessment (DQA) process is the scientific and statistical evaluation of previously verified and validated data to determine if information obtained from environmental data operations are of the right type, quality, and quantity to support their intended use (usability). The DQA process uses the entirety of the collected data to determine usability for decision making. If a statistical sampling design was utilized during field sampling activities, then the DQA will be performed following guidance in EPA/240/B-06/003, *Data*

Quality Assessment: Statistical Methods for Practitioners. When judgmental (focused) sampling designs are implemented in the field, DQIs such as precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity for the specific data sets (individual data packages) will be evaluated in accordance with EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation*. Data verification and data validation are integral to both the statistical DQA data evaluation process and the DQI evaluation process. Results of the DQA or DQI processes will be used by the contractor OU Project Manager to interpret the data and determine if the DQOs for this activity have been met.

3 Field Sampling Plan

This field sampling plan (FSP) directs the sampling and analysis of soil, pore water, aquifer sediment, and groundwater during the drilling and construction of three Milestone M-24-00 groundwater monitoring wells (299-E27-40, 299-E27-27, and 699-43-43B). Wells 299-E27-40 and 299-E27-27 shall support groundwater monitoring at WMA C, while 699-43-43B will support groundwater monitoring at the 216-B-3 Pond. Wells 299-E27-40 and 699-43-43B will support interim status RCRA groundwater monitoring and will replace two corroded stainless steel groundwater monitoring network wells decommissioned in calendar year 2017. Groundwater monitoring well 299-E27-27 is planned to mainly support long-term (i.e., final status) RCRA groundwater monitoring at WMA C. Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, sampling and analysis will also be conducted to support one or more of the following: CERCLA interim action (including extraction well placement), performance assessment fate and transport modeling, assessment of well corrosion, and cumulative impacts evaluation. The FSP uses the sampling design identified during the systematic planning process.

3.1 Sampling Objectives/Design

The objectives of the FSP is to clearly identify and describe sampling and analysis activities that will be performed to resolve decision rules. Decision rules are presented in the DQO as “IF…THEN…ELSE” statements that indicate what action will be taken when a prescribed condition is achieved. The rules incorporate previous DQO steps (i.e., goals, information inputs, boundaries of the study) and outcomes that will result.

Drilling and well construction shall be performed to provide access to the subsurface for the purpose of characterization and to evaluate potential releases of hazardous waste in the underlying aquifer. The scope of activities includes sampling and analysis of vadose zone soil, pore water, aquifer sediments, and groundwater, geologic and geophysical logging, and well development. Within the scope of the groundwater sampling, vertical profiling is planned across the saturated thickness 15.5 m (51 ft) of the aquifer at 299-E27-40 and 299-E27-27 during drilling to support placement of the sample pump. At 699-43-43B a low-flow, low-volume sampling method will be used for vertical profiling in the aquifer after well development. This activity will also support the placement of a sample pump across the saturated thickness of the aquifer (<3.6 m [<12 ft]).

The sampling design for this SAP is based on judgmental sampling. In judgmental sampling, the selection of sampling units (i.e., the number and location and/or timing of collecting samples) is based on knowledge of the feature or condition under investigation (i.e., previous sampling) and on professional judgment. Judgmental sampling is distinguished from probability-based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment. Sample design, sample methods, locations, frequencies, constituents/contaminants of interest, procedures, and documentation requirements are identified in the section. Analytical laboratory requirements are shown in Table 2-3 of the SAP.

3.2 Sample Location, Frequency, and Constituents

Sample locations, depths of sample collection by media (frequency), and constituents/parameters that will be analyzed are described in this section. The scope of the sample design includes collection of soil, sediment, pore water, and groundwater for chemical, radiological, and geotechnical analysis relative to

depth in feet below ground surface. The sample design for each well is unique and based on the DQO process presented in Appendices A and B.

3.2.1 Sample Location

The proposed locations of groundwater monitoring wells 299-E27-40 (Northing 136497: Easting 575030), 299-E27-27 (Northing 136393.2: Easting 575098.5), and 699-43-43B (Northing 136655.5: Easting 576746.6) are shown in Figure 3-1. Groundwater monitoring wells 299-E27-40 and 299-E27-27 are located within the boundary of the 200 East Area and adjacent to WMA C. 699-43-43B is located adjacent to the 200 East Area and positioned within the boundary of waste site 216-B-3 Pond. The location of each well shall be staked prior to drilling, sampling, and well construction activities.

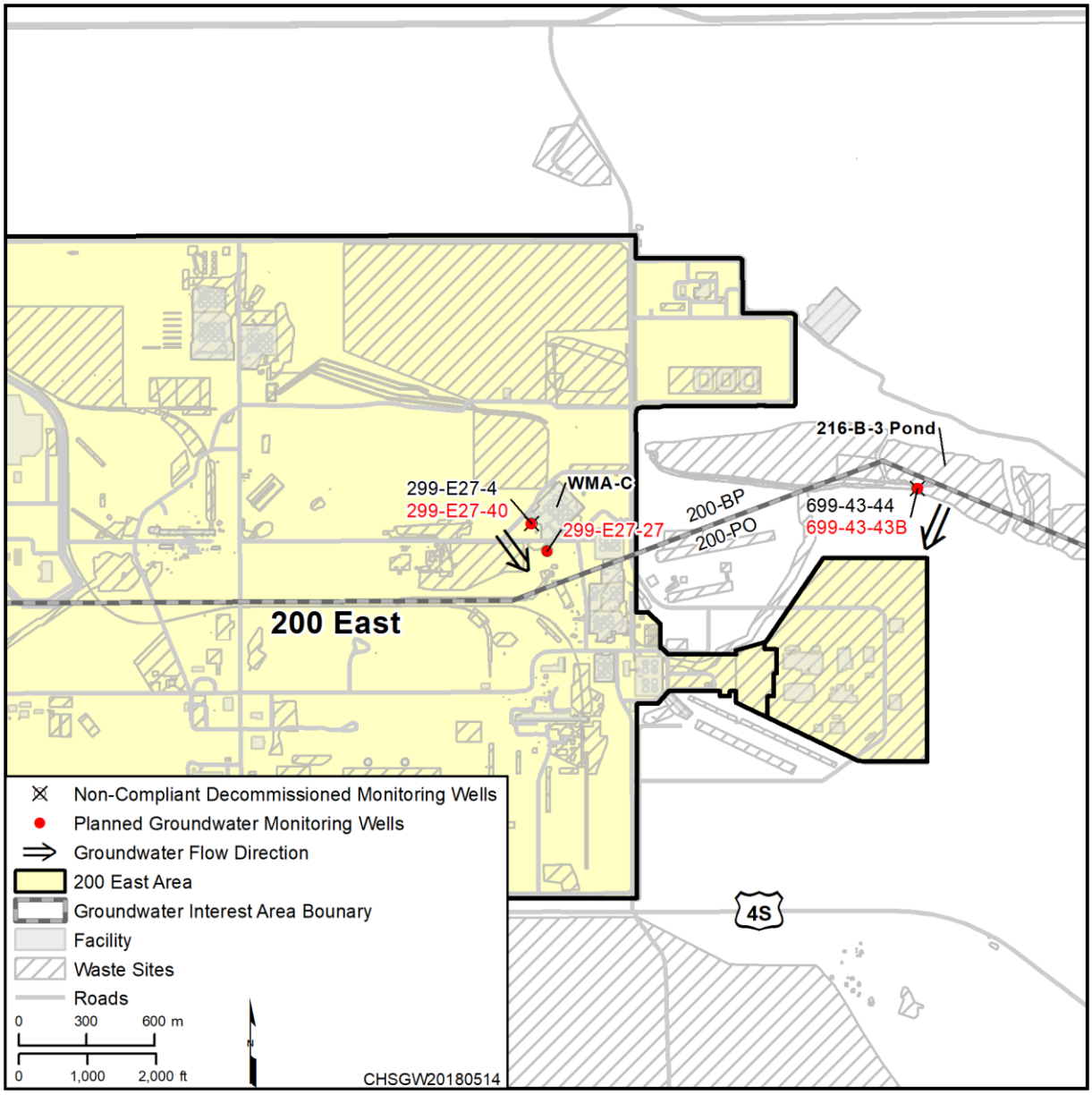


Figure 3-1. Location Map of Groundwater Monitoring Wells

3.2.2 Frequency

Vadose and saturated zone soil, pore water, aquifer sediments, and groundwater sampling shall be collected according to this FSP. For wells 299-E27-40 and 299-E27-27 sampling will be conducted during drilling (i.e., before final screen installation and development). With exception of geologic and geophyscial logging, characterization of the vadose zone is not required in 299-E27-27. The approximate depth of sampling within each well is identified in Table 3-1. The generic sample design for 299-E27-40 and 299-E27-27 are shown in Figure 3-2.

In groundwater monitoring well 699-43-43B, soil, aquifer sediment, and groundwater sampling is required. Groundwater sampling in well 699-43-43B will be conducted with a low-flow pump or other suitable device, after installation of the final well screen and well development. The approximate depth of sampling is identified in Table 3-2. The generic sample design for 699-43-43B is shown in Figure 3-3.

At the discretion of the project scientist, additional samples may be collected based on field screening results and observations.

Table 3-1. Generic Sample Design for Groundwater Monitoring Wells 299-E27-40 and 299-E27-27

Sample Collection Method	Soil Sample Interval – Chemical Analysis[a,b]	Soil Sample Interval – Geotechnical Soil Properties Analysis[c]	Aquifer Sediment Samples[d]	Groundwater Samples[e]
Split spoon/pump[f]	10-12.5	10-12.5	277	277
	12.5-15	12.5-15	282	282
	20-22.5	20-22.5	287	287
	22.5-25	22.5-25	292	292
	30-32.5	30-32.5	297	297
	32.5-35	32.5-35	302	302
	35-37.5	35-37.5	307	307
	37.5-40	37.5-40	312	312
	45-47.5	45-47.5	317	317
	50-52.5	50-52.5	322	322
	70-72.5	70-72.5		
	110-112.5	100-102.5		
	145-147.5	130-132.5		
	155-157.5	160-162.5		
	182.5-185	190-192.5		
	200-202.5	220-222.5		
	225-227.5	242.5-245		
	235-237.5	255-257.5		
	240-242.5			
	245-247.5			
	270-272.5			
Number of samples	21	18	10/10	10/10

Table 3-1. Generic Sample Design for Groundwater Monitoring Wells 299-E27-40 and 299-E27-27

Sample Collection Method	Soil Sample Interval – Chemical Analysis[a,b]	Soil Sample Interval – Geotechnical Soil Properties Analysis[c]	Aquifer Sediment Samples[d]	Groundwater Samples[e]
Summary				
Number of split spoons samples			28	
Number of grab samples			10/10	
Number of water samples			10/10	
Approximate number of field quality control samples			As specified in Table 2.4	

Note: Sample depths may be adjusted based on field conditions and the depth to water table. All depths are below ground surface (bgs) in feet. Only aquifer sediment and groundwater samples will be collected in 299-E27-27. Vadose zone soil sampling is not required in 299-E27-27.

a. Soil analysis: Anions, inductively coupled plasma metal, mercury, total cyanide, uranium, polychlorinated biphenyls, pH, ammonia, volatile organic analysis (1,1,2-trichloroethylene, 4-methyl-2-pentanone, m-xylene, o-xylene, p-xylene, xylenes, 2-butanone, acetone), semivolatile organic analysis (tributyl phosphate), sulfide, total organic carbon, radionuclides (americium-241; antimony-125; carbon-14; cesium-137; cobalt-60; curium-244; europium-152, -154, -155; iodine-129; neptunium-237; nickel-63; plutonium-238, -239/240, -241; selenium-79; strontium-90; technetium-99; thorium-228, -230, -232; tritium; uranium-233/234, 235/236, -238). This list is mainly from RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 6.

b. In addition to the inductively coupled plasma metals, anions, technetium-99, cyanide, water, and soil samples listed in this table, vadose zone extraction of water will also be performed on soil samples at the laboratory. The water extraction (at 1:1 sediment/water ratio) is the aqueous contaminant fraction extracted in the deionized water with a 1-hour sediment contact time. pH and specific conductance shall also be performed on the extract.

c. Geotechnical soil properties analysis 0 to 30.5 m (0 to 100 ft) bgs: gravimetric moisture content. Geotechnical soil property analysis >30.5 m (>100 ft) bgs; unsaturated hydraulic conductivity, saturated hydraulic conductivity, matrix potential using filter paper, grain size distribution, gravimetric moisture content, bulk density, and porosity.

d. Representative geologic grab samples shall be collected for grain size analysis only. Collection with drive barrel is acceptable.

e. Water analysis: Field indicator parameters (pH, temperature, conductivity, turbidity). After field oxygen levels are >5,000 μg/L and oxygen reduction potential are >25 mV, anions, inductively coupled plasma metals, free cyanide, pH, iodine-129, selenium-79, and technetium-99. The intent is to collect samples every 1.5 m (5 ft) across the saturated thickness of the aquifer.

f. The primary sampling device in soils is the split spoon sampler with liners. A drive barrel or equivalent sampling device may be used to collect representative samples of aquifer sediment. A submersible pump may be used to collect groundwater samples.

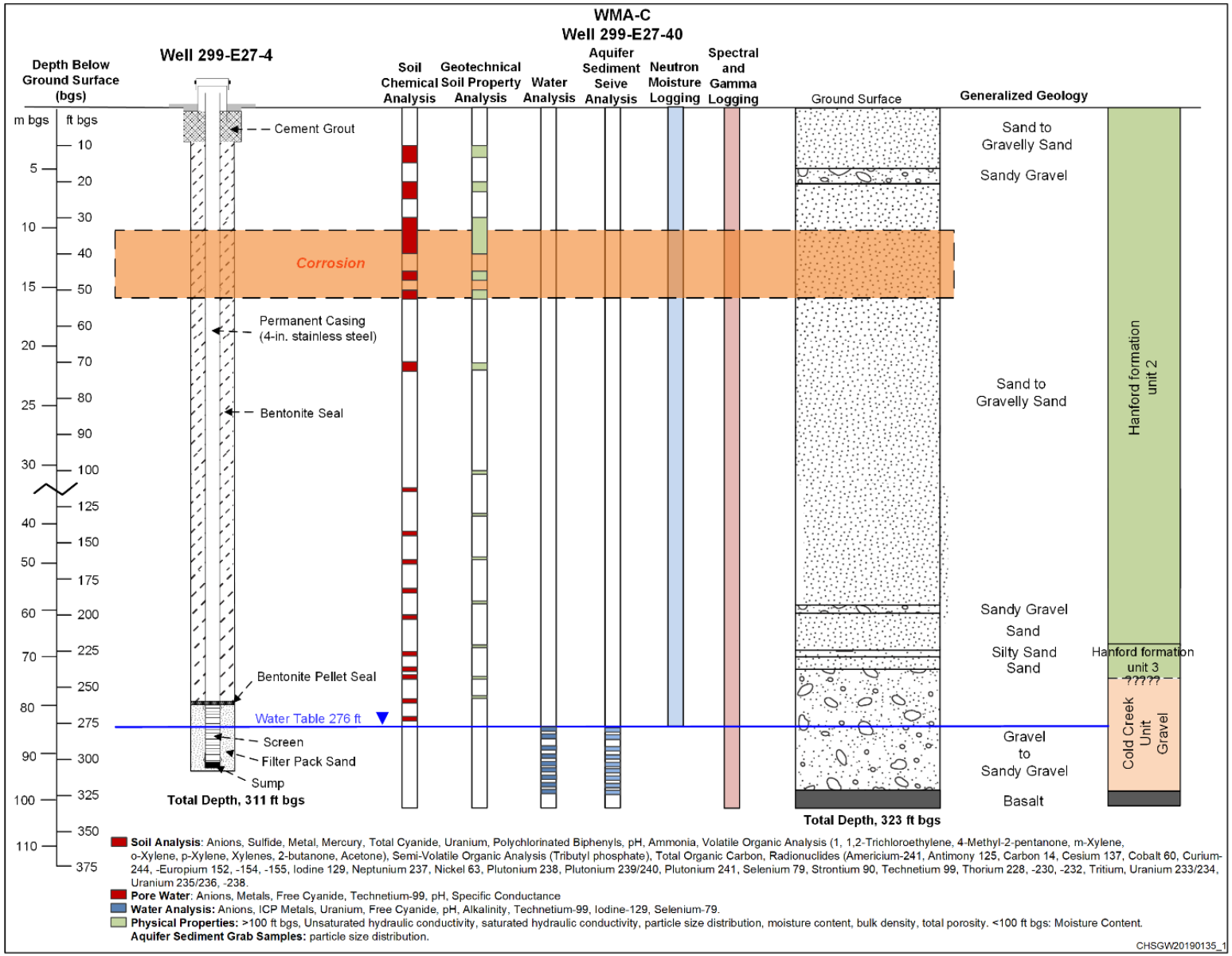


Figure 3-2. 299-E27-40 Sample Design (Including 299-E27-27)

Table 3-2. Generic Sample Design for Groundwater Monitoring Well 699-43-43B

Sample Collection Method	Soil Sample Interval – Chemical Analysis[a]	Soil Sample Interval – Geotechnical Soil Properties Analysis – Moisture Content Only	Groundwater Samples[a]
Split spoon/pump[b]	10-12.5 12.5-15 25-27.5 30-32.5 32.5-35 35-37.5 37.5-40 70-72.5	10-12.5 12.5-15 25-27.5 30-32.5 32.5-35 35-37.5 37.5-40 70-72.5	187 191
Number of samples	8	8	2
Number of split spoon samples	8		
Number of water samples	2		
Approximate number of quality control samples	As specified in Table 2-4.		

Note: Sample depths may be adjusted based on field conditions and the depth to water table. All depths are below ground surface in feet.

a. Anions, pH, inductively coupled plasma metals, iodine-129, tritium.

b. The primary sampling device in soils is the split spoon sampler with liners. A low-flow or submersible pump shall be used to collect groundwater samples.

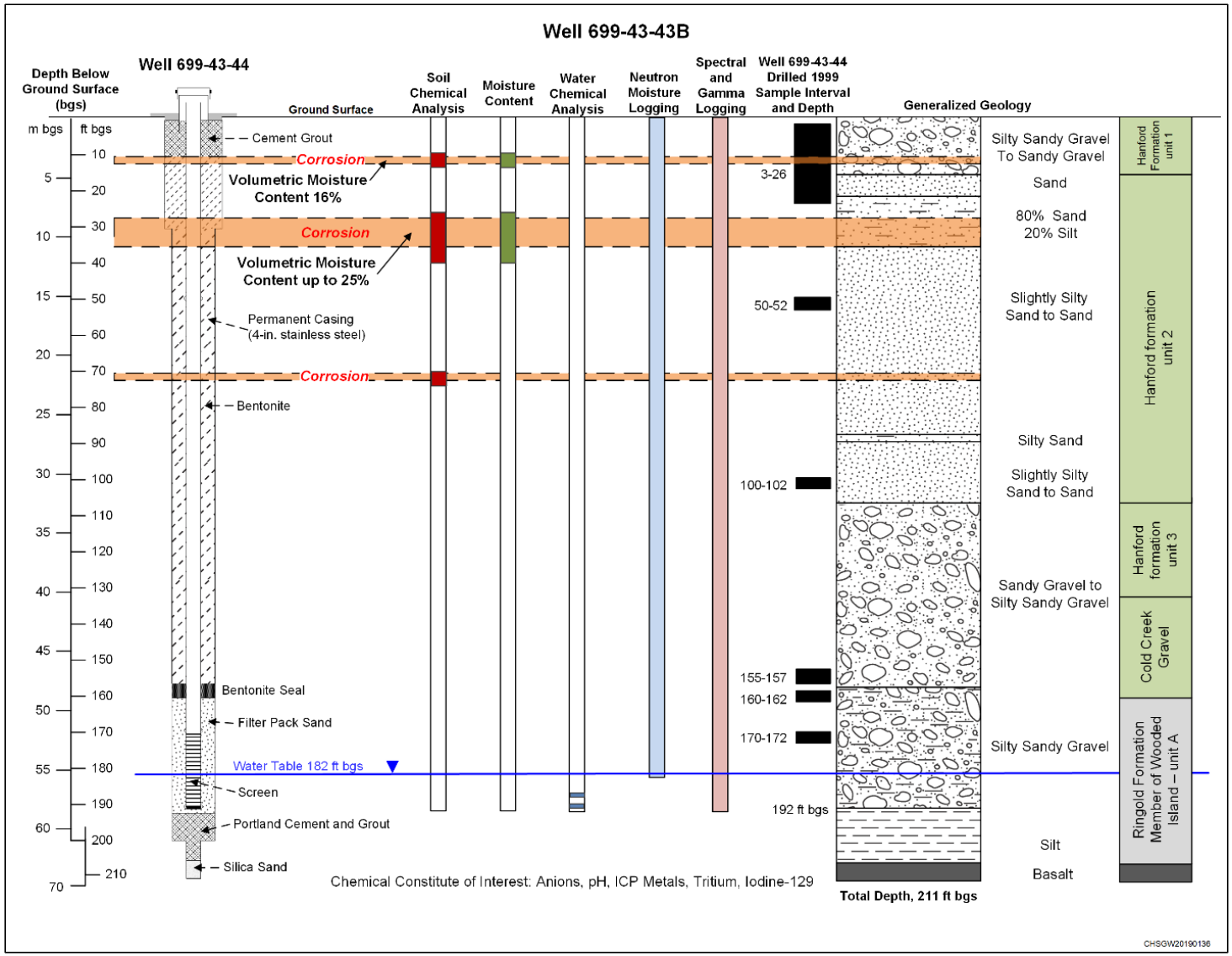


Figure 3-3. 699-43-43B Well Sample Design

3.2.3 Constituent/Parameters

WMA C. WMA C soil samples will be collected from the vadose zone and aquifer sediments in 299-E27-40 and analyzed for chemical, radiological, and geotechnical constituents/parameters of interest in Table 3-1. Vadose zone extraction of water shall also be performed on inductively coupled plasma metals, anions, technetium-99, and cyanide samples at the laboratory. The water extraction (at 1:1 sediment/water ratio) is the aqueous contaminant fraction extracted in the deionized water with a 1-hour sediment contact time. pH and specific conductance shall also be performed on the extract. As outlined in Table 3-1, footnote d, only grain size analysis shall be performed on aquifer sediment from 299-E27-27.

Groundwater water samples will be collected from the aquifer during drilling in 299-E27-40 and 299-E27-27. Each sample will be screened in the field for pH, temperature, conductivity, turbidity, dissolved oxygen, and oxidation reduction potential. When dissolved oxygen is >5,000 μg/L and the oxidation reduction potential is >25 mV, samples shall be collected for analysis: anions, inductively coupled plasma metals, free cyanide, pH, iodine-129, selenium-79, and technetium-99. The OU Technical Lead shall be contacted if screening levels cannot be achieved prior to sampling

216-B-3 Pond. 216-B-3 Pond soil samples will be collected from the vadose zone in 699-43-43B and analyzed for anions, inductively coupled plasma metals, pH, iodine-129, tritium, and moisture content. Because of the limited saturated thickness of the aquifer expected in 699-43-44B, only two groundwater water samples will be collected. The samples will be collected after well development. Each sample will be screened in the field for pH, temperature, conductivity, and turbidity. Groundwater samples are collected after field measurements of purged groundwater have stabilized as follows:

- pH – two consecutive measurements agree within 0.2 pH units
- Temperature – two consecutive measurements agree within 0.2°C (32.3°F)
- Conductivity – two consecutive measurements agree within 10% of each other
- Turbidity – <5 nephelometric turbidity units prior to sampling

216-B-3 Pond groundwater samples shall be collected for the following analysis: anions, inductively coupled plasma metals, iodine-129, and tritium.

3.3 Sampling Methods

Soil samples collected for chemical analysis will be collected with a lined split spoon sampler or similar device. The split spoon and liner shall have been decontaminated according to the sampling decontamination procedure. The split spoon sampler is typically 0.76 m (2.5 ft) long with the shoe and shall not be overdriven. A split spoon sampler and liners will also be used for collection of geotechnical soil properties such as hydraulic conductivity. However, the less stringent drilling equipment decontamination procedure is appropriate during collection for geotechnical soil properties and drive barrel sampling. Other methods of collecting representative soil samples for chemical analysis may also be used during drilling.

Three traditional types of environmental grade sampling pumps (i.e., Grundfos®, Hydrostar®, and submersible electrical pumps) are used for groundwater sampling on the Hanford Site. A submersible pump will likely be used to collect groundwater samples during drilling in 299-E27-40 at WMA C.

®Grundfos is a registered trademark of Grundfos Corporation, Bjerringbro, Denmark.
®Hydrostar is a registered trademark of Chemstar Products Company in Minneapolis, Minnesota.

Low purge-volume sampling methodology for the collection of groundwater samples is also being implemented at the Hanford Site. Low-flow purging and sampling uses a low purge volume, adjustable rate bladder pump with flow rates typically on the order of 0.1 to 0.5 L/min (0.26 to 0.13 gal/min). This methodology is intended to minimize excessive movement of water from the soil formation into the well. The objective is to pump in a manner that minimizes stress (drawdown) to the system. Purge volumes for wells using low purge bladder pumps are determined on a well-specific basis based on drawdown, pumping rate, pump and sample line volume, and volume required to obtain stable field conditions prior to collecting samples. A low-flow pump will likely be used in 699-43-43B to collect groundwater samples after well construction, but before long-term groundwater monitoring commences. Depending on screen length, a low purge volume pump may also be used in 299-E27-40 and 299-E27-27 after well construction.

3.3.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples; care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Decontamination of sampling equipment is performed using high purity water in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: a detergent rinse, an acid rinse, and a water rinse. During the detergent rinse, the equipment is washed in a phosphate-free detergent solution, followed by rinsing with high-purity water in three sequential containers. After the third high-purity water rinse, equipment that is stainless steel or glass is rinsed in a 1 M nitric acid solution (pH <2). Equipment is then rinsed with high-purity water in three sequential containers (the high-purity water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final high-purity water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at 50ºC (122°F) for items that are not metal or glass or at 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for 20 minutes and then cooled. The equipment is then removed from the oven, and the equipment is wrapped in clean, unused aluminum foil using surgeon’s gloves. The wrapped equipment is stored in a custody locked, controlled access area.

To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed, washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. The pump is then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes. The pump is removed from solution and rinsed with high-purity water. The pump is submerged in high-purity water, and 30.3 L (8 gal) of high-purity water is pumped through the unit and disposed. The pump is removed from the high-purity water and the intake and housing are covered with plastic sleeving. The cleaning is documented on a tag affixed to the pump, which includes the following information:

- Date pump cleaned
- Pump identification
- Comments
- Signature of person performing decontamination

The drill rig derrick, all downhole equipment, and temporary casing will be field decontaminated (e.g., high pressure and temperature wash), at a minimum, before mobilization and demobilization at each drilling location. If core barrel equipment is used to collect samples, the drive head will be wiped down between sampling events.

3.3.2 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. Radiological screening will be performed by the RCT or other qualified personnel. The RCT will record field measurements, noting the depth. Measurements will be relayed to the field geologist for inclusion in the field logbook or operational records, as applicable.

The following information will be provided to field personnel performing work in support of this SAP:

- Instructions to RCTs on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the portable radiological field instrumentation including: a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site to obtain measurements of removable surface contamination measurements and direct measurements of the total surface contamination.
- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, “Occupational Radiation Protection.”
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of radiological information.
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related information.
- The requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

Continuous RCT coverage in the vadose zone will be required at each site during drilling because the wells are located within and adjacent to waste sites. The information will support characterization efforts during drilling.

3.4 Documentation of Field Activities

Logbooks are required for field sampling activities. The logbook must be identified with a unique project name and number. Only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes. Data forms are also required for field activities and shall be controlled in accordance with internal work requirements and processes.

Logbooks will be used in accordance with HASQARD (DOE/RL-96-68) requirements. Logbook entries will be reviewed by the FWS, cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms for sampling will be used to collect some field information; however, information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks or on the data forms is as follows:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task.
- Purpose of visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Also, details of any field tests that were conducted; reference to any forms that were used, other data records, and methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and the preparation (if any) of splits, duplicates, matrix spikes, or blanks. Reference the methods followed in sample collection or preparation; list location of sample collected, sample type, each label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and analytical request form number pertinent to each sample or sample set; and note the time and the name of the individual to whom custody of samples was transferred.
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed. Reference the page numbers of any logbook where detailed information is recorded.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

3.4.1 Corrective Actions and Deviation for Sampling Activities

The OU Project Manager, FWS, appropriate field crew supervisors, and SMR personnel must document deviations from protocols, issues pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected due to field conditions.

As appropriate, such deviations or issues will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The OU Project Manager, FWS, field crew supervisors, or SMR personnel will be responsible for communicating field corrective action requirements and for ensuring corrective actions are applied to field activities as soon as practical.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Table 2-2.

3.5 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records shall include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. The results from all instrument calibration activities are recorded in accordance with HASQARD (DOE/RL-96-68) requirements.

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified QC criteria.
- Calibration of radiological field instruments on the Hanford Site is performed by the Mission Support Alliance prime contractor, as specified by their calibration program.
- Daily calibration checks will be performed and documented for each instrument used. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be enough to establish detection efficiency and resolution.
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system. Manufacturer's recommendations for storage and handling of standards (if any) will be followed. Expired standards will not be used for calibration.

3.6 Sample Handling

Sample handling and transfer will be in accordance with established methods and procedures to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date. If during the chain-of-custody process it is discovered that the custody tape has been tampered with or broken on the sample bottle, SMR personnel will be notified, the sample will be analyzed but the results will include a flag to indicate that custody was broken. If the custody tape has been tampered with or broken on the cooler, this condition will be documented in the data package.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

3.6.1 Containers

Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the laboratory lot number of the bottles used in sample collection. When commercially pre-cleaned containers are used in the field, the name of the manufacturer, lot identification, and certification shall be retained for documentation.

Containers shall be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

The Radiological Control organization will measure both the contamination levels and dose rates associated with the filled sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's radioactivity acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the FWS (in consultation with the SMR organization) can send smaller sample volumes to the laboratory.

3.6.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, and collector's name or initials. Sample labels may be either pre-printed or handwritten in indelible or waterproof ink.

3.6.3 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure that sample integrity is maintained throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each sample or set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for the custody of the sample changes, new and previous custodians will sign the record and note the date and time. The field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group.

The following minimum information is required on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number

- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Number of sample containers per unique sample identification number
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group so special direction for analysis can be provided to the laboratory if deemed necessary.

3.6.4 Sample Transportation

Packaging and transportation instructions shall comply with applicable transportation regulations and DOE requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 177, "Carriage by Public Highway."[2] Carrier-specific requirements defined in the current edition of International Air Transportation Association (IATA), 2019, *Dangerous Goods Regulations*, shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents above regulated amounts shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be packaged, marked, labeled, and shipped according to the specific instructions for that material. Appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

Materials are classified by DOT/IATA as radioactive when the isotope specific activity concentration and the exempt consignment limits described in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings," are exceeded. Samples shall be screened, or relevant historical data will be used, to determine if these values are exceeded. When screening or historical data indicate samples are radioactive, they shall be properly classified, described, packaged, marked, labeled, and transported according to DOT/IATA requirements.

Prior to shipping radioactive samples to the laboratory, the organization responsible for shipping shall notify the laboratory of the approximate number of and radiological levels of the samples. The laboratory is responsible for ensuring that the applicable license limits are not exceeded. Prior to sample receipt, the laboratory shall provide SMR with written acceptance for samples with elevated radioactive contamination or dose.

[2] Transportation regulations 49 CFR 174, "Carriage by Rail," and 49 CFR 176, "Carriage by Vessel," are not applicable, as these two transportation methods are not used.

4 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2017-64, *Post Remedial Investigation Waste Control Plan and Removal Action Waste Management Plan for the 200-BP-5 Operable Unit*, for wells 299-E27-40 and 299-E27-27, and DOE/RL-2004-18, *Waste Control Plan for 200-PO-1 Operable Unit*, for well 699-43-43B. For waste designation purposes, 299-E27-40 and 699-43-43B may be surveyed in HEIS, and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if required. These waste control plans establish the requirements for the management and disposal of waste associated with groundwater wells in the 200-BP-5 and 200-PO-1 OUs. Waste from drilling and sampling activities will be handled in accordance with CERCLA requirements.

Miscellaneous solid waste that has contacted suspect dangerous waste will be managed as dangerous waste. Purgewater and decontamination fluids will be collected and managed in accordance with DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*, and DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*. Packaging and labeling during waste storage and transportation will meet the applicable substantive federal and/or state requirements. Waste materials requiring collection will be placed in containers appropriate for the material and the receiving facility in accordance with the applicable waste management or waste control plan and applicable substantive federal and/or state requirements.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes generated from analytical processes.

This page intentionally left blank.

5 Health and Safety

DOE established the hazardous waste operations safety and health program pursuant to the *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in mixed-waste site activities. The program was developed to comply with the requirements of 10 CFR 851, "Worker Safety and Health Program," which incorporates the standards of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response"; 10 CFR 830, "Nuclear Safety Management"; and 10 CFR 835. The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training; control of industrial safety and radiological hazards; personal protective equipment; site control and general emergency response to spills, fire, accidents, injury, site visitors; and incident reporting are governed by the health and safety program. Site-specific health and safety plans will be used to supplement the general health and safety program.

This page intentionally left blank.

6 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&rgn=div5&view=text&node=10:4.0.2.5.27&idno=10.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=15c56aeaa1e8ea2a2fb3914f862177e0&mc=true&node=pt10.4.835&rgn=div5.

10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&rgn=div8&view=text&node=29:5.1.1.1.8.8.33.14&idno=29.

49 CFR, "Transportation," *Code of Federal Regulations*, Available at:
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol1/xml/CFR-2009-title49-vol1.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol2/xml/CFR-2009-title49-vol2.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol3/xml/CFR-2009-title49-vol3.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol4/xml/CFR-2009-title49-vol4.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol5/xml/CFR-2009-title49-vol5.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol6/xml/CFR-2009-title49-vol6.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol7/xml/CFR-2009-title49-vol7.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2010-title49-vol8/xml/CFR-2010-title49-vol8.xml.
http://www.gpo.gov/fdsys/pkg/CFR-2010-title49-vol9/xml/CFR-2010-title49-vol9.xml.

171, "General Information, Regulations, and Definitions."

172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

173, "Shippers—General Requirements for Shipments and Packagings."

175, "Carriage by Aircraft."

177, "Carriage by Public Highway."

ASTM D2216-19, 2019, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM D4282-15, 2015, *Standard Test Methods for Determination of Free Cyanide in Water and Wastewater by Microdiffusion*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM D5298-16, 2016, *Standard Test Methods for Measurement of Soil Potential (Suction) Using Filter Paper*, American Society for Testing and Materials, West Conshohocken, Pennsylvania. Available at: https://www.astm.org/Standards/D5298.htm.

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: https://www.nrc.gov/docs/ML1327/ML13274A489.pdf.

APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*, 22nd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.

BHI-01367, 2000, *200-CW-1 Operable Unit Borehole/Test Pit Summary Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0079504H.

CP-47631, 2016, *Model Package Report: Central Plateau Groundwater Model Version 8.3.4, Rev 3*, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0069098H.

CP-60925, 2018, *Model Package Report: Central Plateau Vadose Zone Geoframework Version 1.0*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/alsearch?s=CP-60925.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

DoD/DOE, 2017, as amended, *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*, Version 5.1, U.S. Department of Defense Environmental Data Quality Workgroup and U.S. Department of Energy Consolidated Audit Program, Washington, D.C. Available at: http://www.p2s.com/wp-content/uploads/FINAL-QSM-5.1-SIGNED-010517.pdf.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 4, *Volume 1, Administrative Requirements*; *Volume 2, Sampling Technical Requirements*; *Volume 3, Field Analytical Technical Requirements*; and *Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0081471H.

DOE/RL-2004-18, 2008, *Waste Control Plan for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0807010321.

DOE/RL-2008-59, 2017, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0066771H.

DOE/RL-2009-77, 2010, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0069394H.

DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0094946.

DOE/RL-2011-41, 2011, *Hanford Site Strategy for Management of Investigation Derived Waste*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0093937.

DOE/RL-2017-64, 2017, *Post Remedial Investigation Waste Control Plan and Removal Action Waste Management Plan for the 200-BP-5 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0067184H.

DOE/RL-2018-69, 2019, *Cumulative Impact Evaluation Technical Approach Document*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-02396.

ECF-HANFORD-13-0029, 2017, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington Fiscal Year 2016 Update*, Rev, 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0072357H.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

Ecology Publication No. 04-03-030, 2004, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/publications/summarypages/0403030.html.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf.

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf.

EPA/240/B-06/003, 2006, *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S**,** Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2015-08/documents/g9s-final.pdf.

EPA/240/R-02/004, 2002, *Guidance on Environmental Data Verification and Data Validation*, EPA QA/G-8, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2015-06/documents/g8-final.pdf.

EPA/240/R-02/009, 2002, *Guidance for Quality Assurance Project Plans*, EPA QA/G-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf.

EPA 540-R-08-005, 2009, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*, OSWER No. 9200.1-85, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1002WWF.TXT.

EPA-540-R-2017-001, 2017, *National Functional Guidelines for Inorganic Superfund Methods Data Review*, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2017-01/documents/national_functional_guidelines_for_inorganic_superfund_methods_data_review_01302017.pdf.

EPA-540-R-2017-002, 2017, *National Functional Guidelines for Organic Superfund Methods Data Review*, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2017-01/documents/national_functional_guidelines_for_organic_superfund_methods_data_review_013072017.pdf.

EPA-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196019611.

EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: https://nepis.epa.gov/Exe/ZyPDF.cgi/30002U3P.PDF?Dockey=30002U3P.PDF.

IATA, 2019, *Dangerous Goods Regulations*, current edition, International Air Transport Association, Montreal, Quebec, Canada.

ISO-986, 1967, *B-Plant Phase III Flowsheets*, ISOCHEM INC., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196129100.

Lacombe P., B. Baroux, and G. Beranger, 1993, "Stainless Steels," *Les Editions de Physique Les Ulis*, Paris.

Lindsey, K.A., 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*, Open File Report 96-8, Washington Division of Geology and Earth Resources, Washington State Department of National Resources, Olympia, Washington. Available at: http://www.dnr.wa.gov/Publications/ger_ofr96-8_ringold_formation.pdf.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0906180659.

PNNL-13690, 2001, *Selection of Sampling Pumps Used for Groundwater Monitoring at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/pnnl-13690.pdf.

PNNL-14753, 2006, *Groundwater Data Package for Hanford Assessments*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0912020007. https://pdw.hanford.gov/arpir/pdf.cfm?accession=0912020126.

PNNL-15141, 2008, *Investigation of Accelerated Casing Corrosion in Two Wells at Waste Management Area A-AX*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: Available at: https://digital.library.unt.edu/ark:/67531/metadc896150/.

Price-Anderson Amendments Act of 1988, Pub. L. 100 408, Aug. 20, 1988, 102 Stat. 1066, 42 USC 2010, et seq. Available at: http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

RPP-23403, 2016, *Single Shell Tank Component Closure Data Quality Objectives*, Rev. 6, Washington River Protection Solution, LLC, Northwest, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0075162H.

RPP-CALC-60345, 2016, *Heterogeneous Medial Model for Waste Management Area C Performance Assessment*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. Available at: https://pdw.hanford.gov/document/0064822H.

RPP-RPT-48029, 2010, *Completion Report for Direct Push Characterization at Four Sites in the 241-C Tank Farm*, Rev. 0, Washington River Protection Solution, LLC, Energy Solutions Federal Services, Inc., Northwest, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0075143H.

RPP-RPT-58949, *Model Package Report Flow and Contaminant Transport Numerical Model used in WMA C Performance Assessment and RCRA Closure Analysis*, Draft A pending, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-63020, 2019, Sampling and Analysis Plan for WMA A-AX Focus Area 2 (Southwestern Area of the A Farm), Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-02797.

Sedriks, A.J., 1996, *Corrosion of Stainless Steel*, 2nd ed., John Wiley & Sons, Inc., New York.

SGW-59914, 2016, *WMA C January Through March 2016 Quarterly Groundwater Monitoring Report*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0072441H.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update VI*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/hw-sw846.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

WHC-MR-0391, 1992, *Field Trip Guide to the Hanford Site*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=D196136627.

Appendix A

DQO Systematic Planning Record for WMA C Wells

This page intentionally left blank.

A1 DQO Systematic Planning Record

The U.S. Department of Energy (DOE-RL), Washington State Department of Ecology (Ecology), CH2M HILL Plateau Remediation Company (CHPRC), Washington River Protection Solutions (WRPS), and Intera Geoscience & Engineering Solutions (INTERA) met to conduct the Data Quality Objectives (DQO) process for the purpose of determining the quality and quantity of data to be collected during the drilling and construction of three *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring wells (299-E27-40, 299-E27-27, and 699-34-34B). Wells 299-E27-40 and 699-34-34B replace two corroded groundwater monitoring wells no longer in use (i.e., decommissioned calendar year 2017). Groundwater monitoring well 299-E27-27 is planned to support long-term (i.e., final status) RCRA groundwater monitoring efforts. This appendix documents systematic planning for groundwater monitoring wells 299-E27-40 and 299-E27-27 near Waste Management Area (WMA) C. Appendix B of this document provides the Systematic Planning Record (SPR) for well 699-43-43B.

Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, data will also be collected during drilling and well construction to support multiple Hanford Site contractor characterization needs. The parties jointly reviewed and discussed the available data and information, as well as the proposed investigation. The decisions, action items, and key points of discussion are documented in this record. The Systematic Planning Record (SPR) provided in this appendix documents the process.

Major elements of the DQO process and reference to relevant information are identified as follows:

1. Statement of the Problem (Statement of the Problem the SPR)
2. Identification of the Goals of the Study (Chapter 3 of the Sampling and Analysis Plan [SAP; main text of this document] and the SPR)
3. Identification of Information Inputs (Chapters 1 and 2 of the SAP and the SPR)
4. Definition of the Boundaries of the Study (Data Needs in the SPR)
5. Development of the Analytical Approach (Tables A-1 and A-2 and Figures A-1 and A-2 in the SPR)
6. Specification of Performance or Acceptance Criteria (Sections 2.2 through 2.4 in the SAP and Performance or Acceptance Criteria in the SPR)
7. Development of the Plan for Obtaining Data (Chapter 3 in the SAP and Plan for Obtaining the Data in the SPR)

In some instances, entries in the SPR refer to components of the SAP to avoid duplication of information discussed in the DQO workshop but formally documented in the SAP.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Project Summary

Project Name: M-24-00 Characterization of 299-E27-40 and 299-E27-27 – WMA C	Date: [X-5-2019
Name of Person Completing Record: Kevin Singleton	Position: Geologist
Name of Responsible Manager: William Faught	

Project Background:

WMA C encompasses the 241-C Tank Farm and its boundary is the fence line surrounding the facility. WMA C provided interim storage of radioactive waste, primarily from the bismuth phosphate process, the plutonium-uranium process, and the uranium extraction process. WMA C was constructed from 1944 to 1945 and was used in the late 1940s onward. WMA C contains 16 underground single-shell tanks: twelve 100-series and four 200-series. The 100-series tanks are 23 m (75 ft) diameter with an operating depth of 5 m (15 ft) and a storage capacity of 1,892,700 L (530,000 gal). The 200-series tanks are 6 m (20 ft) in diameter with a 7.3 m (24 ft) operating depth and a storage capacity of 208,000 L (55,000 gal). The tanks are positioned below grade with at least 2 m (7 ft) of soil to shield personnel from radiation exposure.

The DQO process here describes characterization efforts planned during the drilling and construction of RCRA groundwater well (299-E27-40) in WMA C. Drilling and well construction are needed to replace a corroded groundwater monitoring well (decommissioned calendar year 2017) and provide access to the subsurface environment. This DQO also describes characterization efforts planned during the drilling and construction for a second groundwater monitoring well (299-E27-27) that will support long-term (i.e., final status) RCRA groundwater monitoring efforts. Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, data needs identified by multiple Hanford Site users are required to assess/support one or more of the following: CERCLA interim action (including extraction well placement), performance assessment fate and transport modeling, assessment of well corrosion, and cumulative impacts evaluation. As such, this DQO is designed to provide the quality and quantity of data for various data users and create efficiencies to reduce costs.

Groundwater monitoring well 299-E27-40 will be drilled adjacent to the location of corroded groundwater monitoring well 299-E27-4 (decommissioned). The interim status groundwater monitoring well will be drilled from the surface to the top of basalt about 98.4 m (323 ft) below ground surface (bgs). Groundwater monitoring well 299-E27-27 will also be drilled to basalt.

Planning Type:

(If systematic planning is not required, state the reason)

This planning activity utilizes an external planning approach. CHPRC, WRPS, and INTERA project personnel, with review and concurrence by DOE-RL and Ecology, conducted the planning process. The quality and quantity of data identified by this process will be incorporated into a sampling and analysis plan approved by DOE-RL and Ecology.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Organization, Schedule, and Goal

(State the problem, requirements, schedule, PSQs, and outcomes)

State the Problem

(Describe the reason/need for data collection and project goals/objectives)

RCRA groundwater monitoring well 299-E27-40 is planned near a corroded well to support groundwater monitoring efforts in WMA C. Although groundwater monitoring drives the main need for construction of this new replacement well, unplanned releases from WMA C have impacted the vadose zone and aquifer. Additional data is needed to assess CERCLA interim action (including extraction well placement), performance assessment fate and transport modeling, assessment of well corrosion, and the cumulative impact evaluation. A second well, 299-E27-27, is planned mainly to characterize the aquifer and support RCRA groundwater monitoring downgradient of WMA C.

Principal Study Questions *(What questions are data needed to answer?)*	**PSQ 1**	What are the chemical, physical and hydraulic properties in the vadose zone that influence contaminant fate and transport at 299-E27-40?	**PSQ 3**	What is the vertical distribution of contamination across the saturated thickness of the unconfined aquifer in wells 299-E27-40 and 299-E27-27?
	PSQ 2	What is the cause of well corrosion near 299-E27-40 in the vadose zone? a. Is the moisture content in the vadose zone elevated? b. Are chloride, anions, and other constituent concentrations sufficient to cause corrosion?	**PSQ 4**	What is the grain (particle) size distribution within sediments throughout the saturated thickness of the aquifer in wells 299-E27-40 and 299-E27-27?

Define alternative outcomes or actions that can occur upon answering PSQs.	**AA 1**	The chemical, physical, and hydraulic data from the vadose zone will be used to support ongoing maintenance of the performance assessment fate and transport modeling tool for evaluation of future impacts to groundwater and remedial decision making.	**AA 4**	The movement of water in porous media can be evaluated to assess vertical gradients and sample dilution.
	AA 2	Areas in the vadose zone that potentially cause corrosion will be identified. Well design will be modified with alternative materials to mitigate potential impacts associated with corrosion.		
	AA 3	The well screen and pump will be placed within the portion of the aquifer with the highest concentrations of target analytes.		

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Identify the decision statements or estimation statements needed to address the PSQs.	AA 1	Determine whether fate and transport tools consistently verifies predictions regarding impacts to groundwater.
	AA 2	Determine whether there is an existing corrosion potential in the vadose that will impact well design.
	AA 3	Determine whether the screen and pump are within the high concentration portion of the aquifer.
	AA 4	Determine whether vertical gradients are present and samples dilution is likely within the screen interval in the unconfined aquifer.

Data Needs

(Define the spatial and temporal boundaries of the study)

Define what constitutes a sampling unit:

Sampling of vadose zone soils, aquifer sediments, and groundwater are within the scope of this DQO. Soil and sediment sampling shall be conducted with a split-spoon sampler or an equivalent device such as a drive barrel. A pump shall be used to collect groundwater samples.

Spatial Boundaries:

- Sampling is organized to determine one or more of the following: chemical, physical, and hydraulic properties in the vadose zone, the cause of corrosion in the vadose zone, vertical distribution of contamination, and grain-size distribution across the aquifer. The investigation is planned from the surface to the top of basalt 98.4 m (323 ft) bgs at well locations 299-E27-40. Soil sampling and analysis is not within the scope of activities at well 299-E27-27.
- Soil sampling shall be conducted associated with zones of corrosion and to assess contaminant concentrations and geotechnical properties in the vadose zone in 299-E27-40.
- Groundwater samples and particle size data shall be collected across the saturated thickness of the aquifer in wells 299-E27-40 and 299-E27-27.
- The location of the wells 299-E27-40 and 299-E27-27 are shown in Figure A-1. The sample design for soil and groundwater are identified in Table A-1.

Temporal Boundaries:

- Soil and groundwater sampling will be performed during drilling and prior to well development for analysis in Table A-1.

What is the smallest unit upon which decisions or estimates will be made?

For the purpose of soil and sediment sampling, the smallest unit for decision/estimation is the split-spoon sample interval (0.76 m [2.5 ft]). For the purpose of groundwater sampling, the depth of the pump intake is representative of the aquifer.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Data Needs Summary

(Information inputs to answer PSQs: target population, characteristics of interest, spatial and temporal limits, scale of inference)

PSQ	Data Need	Media of Interest	Location	Sampling Method	Action Level	Frequency	Practical Constraints	Analytical Method	Potential Source of Data
1	Data are needed to determine the chemical, physical and hydraulic properties in the vadose zone.	Soil	299-E27-40	Split-spoon sampling	Radiological screening exceeding 2X background and sample examination may trigger additional sampling.	Table A-1 and Figure A-2	Provided in "Plan for Obtaining Data"	Table A-2	Site-specific sampling
2	Data are needed to determine the cause of casing corrosion.	Soil	299-E27-40	Split-spoon sampling	Radiological screening exceeding 2X background and sample examination may trigger additional sampling.	Table A-1 and Figure A-2	Provided in "Plan for Obtaining Data"	Table A-2	Site-specific sampling
3	Data are needed to determine the vertical distribution of contamination in the aquifer.	Aquifer	299-E27-40 and 299-E27-27	Submersible pump or low-flow pump	Not applicable	Table A-1 and Figure A-2	Provided in "Plan for Obtaining Data"	Table A-2	Site-specific sampling
4	Data are needed to determine pump placement.	Aquifer sediments	299-E27-40 and 299-E27-27	Split-spoon sampling	Not applicable	Table A-1 and Figure A-2	Provided in "Plan for Obtaining Data"	Table A-2	Site-specific sampling

Performance or Acceptance Criteria

(Determine the quality of data needed and analytical approach)

Specify the population parameter (e.g., mean, median, or percentile), appropriate for making decisions or estimates:

Judgmental sampling will be used to identify sampling units (i.e., the number and location and/or timing of collecting samples) based on knowledge of the feature under investigation (i.e., previous sampling) and on professional judgment.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Decision Problem	Provide a decision rule related to the Action Level identified above that includes a clear "if…then…else" statement: **PSQ 1**. If site-specific chemistry and physical property data changes fate and transport modeling conclusions, then update the models; else, no changes will be made to models. **PSQ 2**. If the data indicates soil moisture and chemistry contributes to casing corrosion, then modify the well design; else consider a future alternate location for monitoring. **PSQ 3**. If the maximum concentration of contamination is identified deep within the aquifer, then design the well screen and position the pump to collect samples from this region of the well; else install the screen and pump in the uppermost section of the unconfined aquifer. **PSQ 4**. If particle distribution suggest groundwater flow into the well is not laminar, then adjust the depth of the pump; otherwise place the pump and screen in the area of maximum contamination.
	What are the consequences of making an incorrect decision and what is the tolerance for an incorrect decision? **PSQ 1**. If site-specific chemistry and physical property data changes fate and transport modeling conclusions, when in fact the data are not representative of subsurface conditions, future hydraulic, and contaminant impacts to groundwater could be over or underestimated. **PSQ 2**. If the data indicates soil moisture and chemistry contributes to casing corrosion, when in fact soil moisture and chemistry are not the cause of corrosion, then well life might be reduced and additional expenditures may be required to replace the corroded wells. **PSQ 3**. If the maximum concentration of contamination is identified deep within the aquifer, when in fact the maximum concentration is in the upper portion of the aquifer, then the pump will not be located properly and samples will not be representative of maximum concentrations and under represent risk. **PSQ 4**. If particle distribution suggest groundwater flow into the well is not laminar, when in fact groundwater flow in the well is laminar, then the pump will not be located properly and samples will not be representative of maximum concentrations and under represent risk.
Estimation Problem	Develop the specification of the estimator by combining the true value of the selected population parameter with the scale of estimation and other boundaries: • A statistical sampling design is not applicable to this effort; therefore, concentrations detected will only be compared to background levels, cleanup value or both for decision making. The sampling design is based on judgmental sampling.
	What are the acceptable limits on uncertainty? Limits of uncertainty are mainly associated with the dilution of groundwater during sampling and analytical laboratory error. An evaluation of grain-size data from the aquifer, very low pumping rates during sampling and procedures minimizes uncertainties related to sample quality. The limits on analytical uncertainty are specified in the SAP. A robust quality assurance/quality control program minimizes analytical uncertainties.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Plan for Obtaining the Data

(Specify the general plan of obtaining the needed data and explain where and how the information in this Planning Record will be formalized in a data collection plan)

Characterization data necessary to evaluate the PSQs identified in this DQO will be collected during the drilling of well 299-E27-40 by sampling and analyzing vadose zone soils, aquifer sediments, and groundwater. Characterization is also required in well 299-E27-27, but sampling and analysis of the vadose zone is not required. Soils shall be collected and analyzed for anions, sulfide, inductively coupled plasma metals, mercury, total cyanide, uranium, polychlorinated biphenyls, pH, ammonia, total organic carbon, volatile organic analysis (1,1,2-trichloroethylene, 4-methyl-2-pentanone, m-xylene, o-xylene, p-xylene, xylenes, 2-butanone, acetone), semi-volatile organic analysis (tributyl phosphate), radionuclides (americium-241, antimony-125, carbon-14, cesium-137, cobalt-60, curium-244, europium-152, -154, -155, iodine-129, neptunium-237, nickel-63, plutonium-238, plutonium-239/240, plutonium-241, selenium-79, strontium-90, technetium-99, thorium-228, -230, -232, tritium, uranium-233/234, uranium-235/236, -238). Physical properties of interest include unsaturated hydraulic conductivity, saturated hydraulic conductivity, matric potential, grain-size distribution, moisture content, bulk density, and total porosity. Aquifer sediments will be sieved to determine grain-size distribution, while groundwater will be analyzed for anions, alkalinity, inductively coupled plasma metals, free cyanide, technetium-99, iodine-129, selenium-79, after field oxygen levels are >5,000 µg/L and oxygen-reduction potential are >25 mV during drilling but before well completion. In the field, continuous Radiological Control coverage shall be provided for health and safety and identify additional potential zone on contamination. During groundwater sampling of the well, pH, dissolved oxy-redox potential, and specific conductance will be determined in the field. Spectral gamma and neutron moisture geophysical logging and geologic logging is within the scope of activities planned. Additional detail has been documented in the SAP based on the decisions, action items, and key points of discussion from the July 2019 meeting with the DOE-RL, Ecology, CHPRC, and WRPS.

Practical considerations to be accounted for during the planning of sample collection include:

1. Cultural and ecological site restrictions.
2. Not all soil and sediment samples may be collected as planned because of insufficient sample volumes.

The location of WMA C and groundwater monitoring well 299-E27-40 and 299-E27-27 are shown in Figure A-1.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

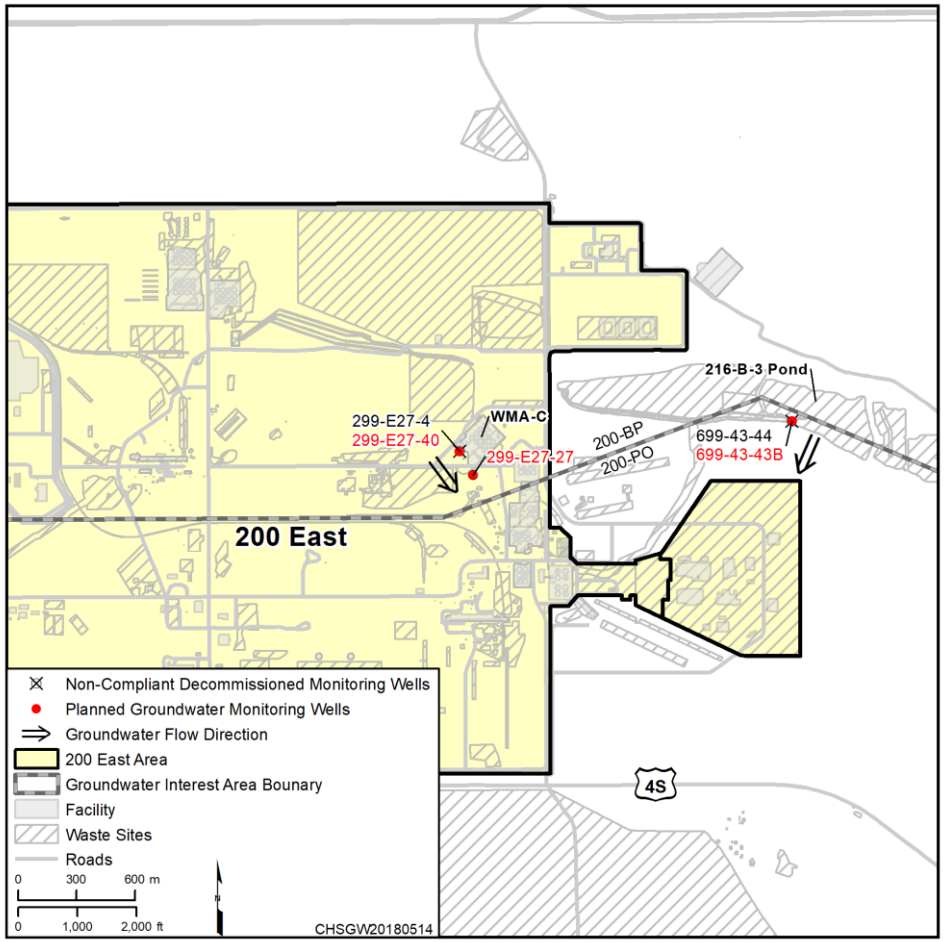


Figure A-1. Well Location Map

Note: Drilling locations may be subject to change pending the identified practical considerations.

Table A-1. Generic Sample Design for Groundwater Monitoring Well 299-E27-40/299-E27-27*

Sample Collection Method	Soil Sample Interval-Chemical Analysis[a,b]	Soil Sample Interval - Geotechnical Soil Properties Analysis[c]	Aquifer Sediment Samples[d]	Groundwater Samples[e]
Split spoon/pump[f]	10-12.5	10-12.5	277	277
	12.5-15	12.5-15	282	282
	20-22.5	20-22.5	287	287
	22.5-25	22.5-25	292	292
	30-32.5	30-32.5	297	297
	32.5-35	32.5-35	302	302
	35-37.5	35-37.5	307	307
	37.5-40	37.5-40	312	312
	45-47.5	45-47.5	317	317
	50-52.5	50-52.5	322	322
	70-72.5	70-72.5		
	110-112.5	100-102.5		
	145-147.5	130-132.5		
	155-157.5	160-162.5		
	182.5-185	190-192.5		
	200-202.5	220-222.5		
	225-227.5	242.5-245		
	235-237.5	255-257.5		
	240-242.5			
	245-247.5			
	270-272.5			
Number of Samples	21	18	10/10	10/10

Summary	
Number of split-spoons samples	28
Number of grab samples	10/10
Number of water samples	10/10
Approximate Number of Field Quality Control	As specified in Table 2-4 of the Sampling and Analysis Plan in the main text of this document

Note: Sample depths may be adjusted based on field conditions and the depth to water table. All depths are below ground surface in feet.

*Only aquifer sediment and groundwater samples will be collected in well 299-E27-27. Vadose zone soil sampling is not required in well 299-E27-27.

a. Soil analysis: anions, inductively coupled plasma metals, mercury, total cyanide, uranium, polychlorinated biphenyls, pH, ammonia, volatile organic analysis (1,1,2-trichloroethylene, 4-methyl-2-pentanone, m-xylene, o-xylene, p-xylene, xylenes, 2-butanone, acetone), semi-volatile organic analysis (tributyl phosphate), sulfide, total organic carbon, radionuclides (americium-241, antimony-125, carbon-14, cesium-137, cobalt-60, curium-244, europium-152, -154, -155, iodine-129,

Table A-1. Generic Sample Design for Groundwater Monitoring Well 299-E27-40/299-E27-27*

Sample Collection Method	Soil Sample Interval-Chemical Analysis[a,b]	Soil Sample Interval - Geotechnical Soil Properties Analysis[c]	Aquifer Sediment Samples[d]	Groundwater Samples[e]

neptunium-237, nickel-63, plutonium-238, plutonium-239/240, plutonium-241, selenium-79, strontium-90, technetium-99, thorium-228, -230, -232, tritium, uranium-233/234, and uranium-235/236, -238. This list is mainly from RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*.

b. In addition to the inductively coupled plasma metals, anions, technetium-99, cyanide water, and soil samples listed in this table, vadose zone extraction of water will also be performed on soil samples at the laboratory. The water extraction (at 1:1 sediment/water ratio) is the aqueous contaminant fraction extracted in the deionized water with a 1-hour sediment contact time. pH and specific conductance shall also be performed on the extract.

c. Geotechnical soil properties 0 to 30.5 m (0 to 100 ft) bgs: gravimetric moisture content. Geotechnical soil properties 30.5 m (>100 ft) bgs; unsaturated hydraulic conductivity, saturated hydraulic conductivity, matrix potential using filter paper, grain-size distribution, gravimetric moisture content, bulk density, and porosity.

d. Representative geologic grab samples shall be collected for grain-size analysis only. Collection with drive barrel is acceptable.

e. Water analysis: Field indicator parameters (pH, temperature, conductivity, turbidity). After field oxygen levels are >5,000 µg/L and oxygen reduction potential are >25 mV, anions, inductively coupled plasma metals, free cyanide, pH, iodine-129, selenium-79, and technetium-99.

f. The primary sampling device in soils is the split-spoon sampler with liners. A drive barrel or equivalent sampling device may be used to collect representative samples of aquifer sediment. A submersible pump may be used to collect groundwater samples.

bgs = below ground surface

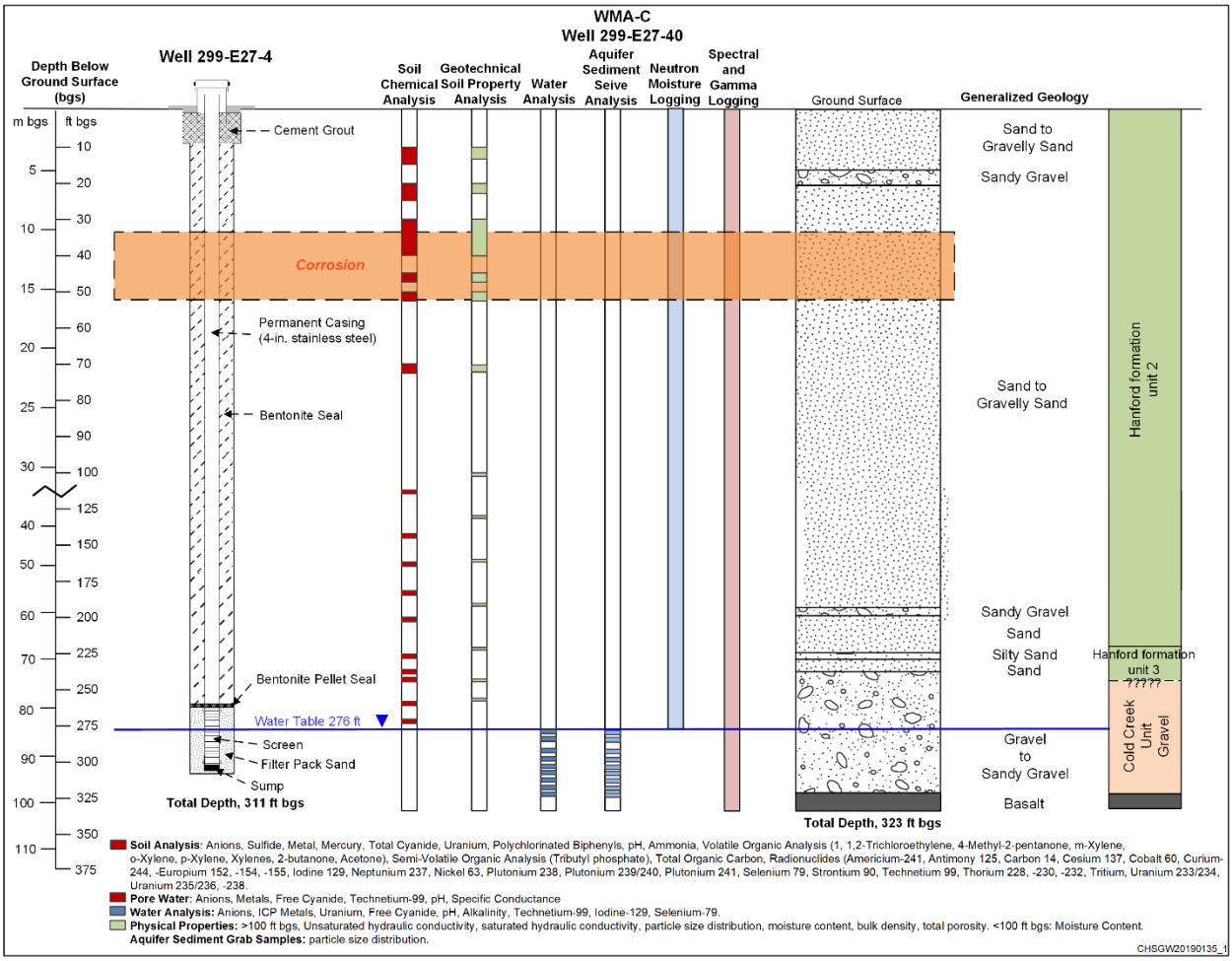


Figure A-2. Visual Presentation of 299-E27-40 and 299-E27-27 Sample Design

Table A-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods[a]	Media		Sample Priority
General Chemical Parameters				
Alkalinity	310.1 or Standard Method 2320	N/A	Water	14
pH[b]	150.1	Soil	Water	5
Specific conductivity[b]	9050	N/A	Water	24
Ammonia and Anions				
Anions[b]	300 or 9056	Soil	Water	1
Sulfide	376.1 or Standard Method 4500S for water, or 9034 for soil	Soil	Water	1

Table A-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods[a]	Media		Sample Priority
Ammonia	350.1	Soil	N/A	21
Metals				
ICP-AES and ICP-MS metals (includes uranium)[b]	6010 and 6020	Soil	Water	13
Cyanide	9012 or 9014 or 335.4 or 4500-CN	Soil	N/A	2
Free cyanide[b]	9014	N/A	Water	3
Mercury	7470 for water, 7471 for soil	Soil	Water	22
Polychlorinated Biphenyls				
Polychlorinated biphenyls	8082	Soil	Water	23
Organics				
Volatile organic analysis	8260	Soil	Water	19
Semi-volatile organic analysis	8270	Soil	Water	20
Total organic carbon	415.1 or 9060	Soil	Water	25
Radionuclides				
Americium-241	Alpha energy analysis	Soil	Water	17
Antimony-125	Low energy gamma or gas proportional counting	Soil	Water	12
Carbon-14	Liquid scintillation counter	Soil	Water	16
Cesium-137	Gamma energy analysis	Soil	Water	12
Cobalt-60	Gamma energy analysis	Soil	Water	12
Curium-244	Alpha energy analysis	Soil	Water	17
Europium-152, -154, -155	Gamma energy analysis	Soil	Water	12
Iodine-129	Low energy gamma spectroscopy or gas proportional counting	Soil	Water	15
Neptunium-237	Alpha energy analysis	Soil	Water	17
Nickel-63	Liquid scintillation counter	Soil	Water	16

Table A-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods[a]	Media		Sample Priority
Plutonium-238, -239/240, 241	Alpha energy analysis	Soil	Water	17
Selenium-79	Liquid scintillation counter	Soil	Water	16
Strontium-90	Gas proportional counting	Soil	Water	18
Technetium-99	Liquid scintillation counter	Soil	Water	16
Thorium-228, -230, -232	Alpha energy analysis	Soil	Water	17
Tritium	Liquid scintillation counter	Soil	Water	24
Uranium-235/236, -238	Alpha energy analysis	Soil	Water	17
Geotechnical Soil Properties				
Unsaturated hydraulic conductivity	PNNL analysis[c]	Soil	N/A	6
Saturated hydraulic conductivity	PNNL analysis[c]	Soil	N/A	7
Matric potential using filter paper	PNNL analysis[c]	Soil	N/A	8
Grain size distribution	PNNL analysis[c]	Soil	N/A	11
Gravimetric moisture content	PNNL analysis[c]/ ASTM D2216	Soil	N/A	4
Bulk density	PNNL analysis[c]	Soil	N/A	9
Total porosity	PNNL analysis[c]	Soil	N/A	10
Field Screening				
Radiological screening by radiological control technician	Continuous - Hanford Site procedure	Soil	NA	Continuous
Dissolved oxygen	Field measurement instrument/meter	N/A	Water	N/A
Oxidation-redox potential	Field measurement instrument/meter	N/A	Water	N/A
pH	Field measurement instrument/meter	N/A	Water	N/A

Table A-2. Target Analytes and Geotechnical Soil Properties of Interest for WMA C

Nonradioactive Analytes	Analytical Methods[a]	Media		Sample Priority
Specific conductivity	Field measurement instrument/meter	N/A	Water	N/A
Temperature	Field measurement instrument/meter	N/A	Water	N/A
Turbidity	Field measurement instrument/meter	N/A	Water	N/A
Spectral gamma logging	Contractor procedure	Soil	Water	Before downsizing casing and at total depth
Neutron moisture logging	Contractor procedure	Soil	N/A	Before downsizing casing and at total depth

References: APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*.

ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D5298-94, *Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper*.

EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Waste*.

RPP-PLAN-63020, *Sampling and Analysis Plan for WMA A-AX Focus Area 2 (Southwestern Area of A Farm)*

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*.

a. For EPA Method 300.0, and 335.4, see EPA/600/R-93/100. For EPA Methods 150.1, 310.1, 350.1, 376.1, and 415.1, see EPA/600/4-79-020. For four-digit EPA methods, see SW-846. For Standard Methods, see APHA/AWWA/WEF. Equivalent methods may be substituted.

b. In addition to the inductively coupled plasma metals, anions, technetium-99, cyanide water and soil samples listed in this table, vadose zone extraction of water will also be performed on soil samples at the laboratory. The water extraction (at 1:1 sediment/water ratio) is the aqueous contaminant fraction extracted in the deionized water with a 1-hour sediment contact time. pH and specific conductance shall also be performed on the extract.

Note: Duplicate sample priority indicates constituents are likely within the same bottle.

c. Geotechnical soil property samples greater than 100 ft below groundwater surface will be collected for WRPS. The samples shall be transported to PNNL and analyzed for the parameters above according to RPP-PLAN-63020, ASTM D2216, and ASTM 5298-94.

EPA = U.S. Environmental Protection Agency

ICP-AES = inductively coupled plasma-atomic emission spectroscopy

ICP-MS = inductively coupled plasma- mass spectrometry

N/A = not applicable

pH = hydrogen ion concentration

PNNL = Pacific Northwest National Laboratory

WMA = waste management area

A2 References

APHA/AWWA/WEF, 2017, *Standard Methods For the Examination of Water and Wastewater*, 23rd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.

ASTM D2216, 2019, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM D5298-94, 1994, *Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30002U3P.txt.

EPA-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196019611.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Pub. L. 94-580, 90 Stat. 2795. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

RPP-23403, 2016, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 6, Washington River Protection Solutions LLC, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0075162H.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/hw-sw846.

RPP-PLAN-63020, 2019, *Sampling and Analysis Plan for WMA A-AX Focus Area 2 (Southwestern Area of A Farm)*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

This page intentionally left blank.

Appendix B

DQO Systematic Planning Record for B Pond Well 699-43-43B

This page intentionally left blank.

B1 DQO Systematic Planning Record

The U.S. Department of Energy (DOE-RL), Washington State Department of Ecology (Ecology), CH2M HILL Plateau Remediation Company (CHPRC), Washington River Protection Solutions (WRPS), and Intera Geoscience & Engineering Solutions (INTERA) met to conduct the Data Quality Objectives (DQO) process for the purpose of determining the quality and quantity on data to be collected during the drilling and construction of three *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring wells (299-E27-40, 299-E27-27, and 699-34-34B). Wells 299-E27-40 and 699-34-34B replace two corroded groundwater monitoring wells no longer in use (i.e., decommissioned calendar year 2017). Groundwater monitoring well 299-E27-27 is planned to support long-term (i.e., final status) RCRA groundwater monitoring efforts. This appendix documents systematic planning for groundwater monitoring well 699-43-43B at 216-B-3 Pond. Appendix A of this document provides the Systematic Planning (SPR) record for wells 299-E27-40 and 299-E27-27B.

Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, data will also be collected during drilling and well construction to assess casing corrosion and the vertical distribution of contamination in the aquifer. The parties jointly reviewed and discussed the available data and information, as well as the proposed investigation. The decisions, action items, and key points of discussion are documented in this record. The process resulted in the SPR.

Major elements of the DQO process and reference to relevant information are identified as follows:

1. Statement of the Problem (Statement of the Problem in the SPR)
2. Identification of the Goals of the Study (Chapter 3 of the Sampling and Analysis Plan [SAP; main text of this document) and the SPR
3. Identification of Information Inputs (Chapters 1 and 2 of the SAP and the SPR
4. Definition of the Boundaries of the Study (Data Needs in the SPR)
5. Development of the Analytical Approach (Tables B-1 and B-2 and Figures B-1 and B-2 in the SPR)
6. Specification of Performance or Acceptance Criteria (Sections 2.2 through 2.4 in the SAP and Performance or Acceptance Criteria in the SPR)
7. Development of the Plan for Obtaining Data (Chapter 3 in the SAP and Plan for Obtaining the Data in the SPR)

In some instances, entries in the SPR refer to components of the SAP to avoid duplication of information discussed in the DQO workshop but formally documented in the SAP.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Project Summary

Project Name: M-24-00 Characterization of 699-43-43B at 216-B-3 Pond	Date: [X-5-2019
Name of Person Completing Record: Kevin Singleton	Position: Geologist
Name of Responsible Manager: William Faught	

Project Background:

The 216-B-3 Pond operated from 1945 to 1994 and received 1.0×10^{12} L (260 billion gal) of effluent. Located in a natural topographic depression, the 14.2 ha (35 ac) pond had a maximum depth of approximately 6.1 m (20 ft) and was used for evaporation and percolation of effluent. During operations, B Pond received effluent from several 200 East Area facilities, including the Plutonium-Uranium Extraction Plant, B Plant, 241-A 401 Building, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant. Corrosive hazardous wastes such as nitric and sulfuric acids were routinely discharged to the pond via the ditches. Other dangerous waste discharged to the pond included cadmium nitrate, ammonium fluoride, ammonium nitrate, hydrazine, and sodium and potassium hydroxide. In 1994, the pond was filled with clean soil during interim stabilization activities. All vegetation was removed from the perimeter and incorporated with the fill soil.

The DQO process here describes characterization efforts planned during the drilling and construction of RCRA groundwater well 699-43-43B in 216-B-3 Pond. Drilling and well construction are needed to replace a corroded groundwater monitoring well (decommissioned calendar year 2017) and provide access to the subsurface environment. Although RCRA groundwater monitoring provides the impetus for drilling and groundwater well construction, data are needed to assess casing corrosion and the vertical distribution of contamination in the aquifer. As such, this DQO is designed to provide the quality and quantity of data as defined by data need(s).

Groundwater monitoring well 699-43-43B will be drilled adjacent to the location of corroded groundwater monitoring well 699-43-44 (decommissioned). The interim status groundwater monitoring well will be drilled from the surface to the bottom of the unconfined aquifer about 59 m (192 ft) below ground surface (bgs).

Planning Type:

(If systematic planning is not required, state the reason)

This planning activity utilizes an external planning approach. CHPRC, WRPS, INTERA project personnel with review and concurrence by (DOE-RL) and Ecology, conducted the planning process. The quality and quantity of data identified by this process will be identified in a sampling and analysis plan approved by DOE/RL and Ecology.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Organization, Schedule, and Goal

(State the problem, requirements, schedule, PSQs, and outcomes)

State the Problem

(Describe the reason/need for data collection and project goals/objectives)

RCRA groundwater monitoring well 699-43-43B is planned near a corroded well to support groundwater monitoring efforts at 216-B-3 Pond. Although groundwater monitoring drives the main need for construction of this new replacement well, historical planned releases to the pond have also impacted the vadose zone. The vadose zone was characterized during a 1999 remedial investigation; however, data are needed to evaluate the cause of casing corrosion and the vertical distribution of contamination in the aquifer. Data are needed to assess the cause of corrosion, hydraulic properties in the vadose zone and the vertical distribution of contamination in the aquifer.

Principal Study Questions *(What questions are data needed to answer?)*	**PSQ 1**	What is the cause of well corrosion near 699-43-44 in the vadose zone? a. Is the moisture content in the vadose zone elevated? b. Are chloride, anions, pH and other constituent concentrations sufficient to cause corrosion?	**PSQ 3**	What is the grain (particle) size distribution within sediments throughout the saturated thickness of the aquifer?
	PSQ 2	What is the vertical distribution of contamination across the saturated thickness of the unconfined aquifer?		

Define alternative outcomes or actions that can occur upon answering PSQs.	**AA 1**	Areas in the vadose zone that potentially cause corrosion will be identified. Well design will be modified with alternative materials to mitigate potential impacts associated with corrosion.	**AA 3**	The movement of water in porous media can be evaluated to assess vertical gradients and sample dilution.
	AA 2	The well screen and pump will be placed within the portion of the aquifer with the highest concentrations of target analytes.		

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Identify the decision statements or estimation statements needed to address the PSQs.	AA 1	Determine whether there is an existing corrosion potential in the vadose zone that will impact well design.
	AA 2	Determine whether the screen and pump are within the high concentration portion of the aquifer.
	AA 3	Determine whether vertical gradients are present and samples dilution is likely within the screen interval in the unconfined aquifer.

Data Needs

(Define the spatial and temporal boundaries of the study)

Define what constitutes a sampling unit:

Sampling of vadose zone soils, aquifer sediments and groundwater are within the scope of this DQO. Soil and sediment sampling shall be conducted with a split spoon sampler or an equivalent device such as a drive barrel. A pump shall be used to collect groundwater samples

Spatial Boundaries:

- Sampling is organized to determine the cause of well corrosion within the vadose zone, contaminant distribution in the aquifer and where the well screen and pump will be placed. The investigation is planned from the surface to the bottom of the unconfined aquifer 58.2 m (191 ft) bgs at well 699-43-43B.
- Soil sampling shall be conducted associated with zones of corrosion in the vadose zone.
- Groundwater samples and particle size data shall be collected across the saturated thickness of the aquifer.
- The location of the well 699-43-34B is shown in Figure B-1. The sample design for soil and groundwater are identified in Table B-1.

Temporal Boundaries:

- Soil and groundwater sampling will be performed during drilling and well construction efforts (otherwise, before interim status groundwater monitoring begins) for the analysis in Table B-1.

What is the smallest unit upon which decisions or estimates will be made?

For the purpose of soil and sediment sampling, the smallest unit for decision/estimation is the split-spoon sample interval (0.76 m [2.5 ft]). For the purpose of groundwater sampling, the depth of the pump intake is representative of the aquifer.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Data Needs Summary

(Information inputs to answer PSQs: target population, characteristics of interest, spatial and temporal limits, scale of inference)

PSQ	Data Need	Media of Interest	Location	Sampling Method	Action Level	Frequency	Practical Constraints	Analytical Method	Potential Source of Data
1	Data are needed to determine the cause of casing corrosion.	Soil	699-43-43B	Split-spoon sampling	Radiological screening exceeding 2X background and sample examination may trigger additional sampling.	Table B-1 and Figure B-2	Provided in "Plan for Obtaining Data"	Table B- 2	Site-specific sampling
2	Data are needed to determine the vertical distribution of contamination in the aquifer.	Aquifer	699-43-43B	Submersible pump or low flow pump	Not applicable	Table B-1 and Figure B-2	Provided in "Plan for Obtaining Data"	Table B-2	Site-specific sampling
3	Data are needed to determine pump placement.	Aquifer sediments	699-43-34B	Split-spoon sampling	Not applicable	Table B-1 and Figure B-2	Provided in "Plan for Obtaining Data"	Table B-2	Site-specific sampling

Performance or Acceptance Criteria

(Determine the quality of data needed and analytical approach)

Specify the population parameter (e.g., mean, median, or percentile), appropriate for making decisions or estimates:

Judgmental sampling will be used to identify sampling units (i.e., the number and location and/or timing of collecting samples) based on knowledge of the feature under investigation (i.e., previous sampling) and on professional judgment.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Decision Problem	Provide a decision rule related to the Action Level identified above that includes a clear "if…then…else" statement: **PSQ 1**. If the data indicate soil moisture and chemistry contributes to casing corrosion, then modify the well design; else consider a future alternate location for monitoring. **PSQ 2**. If the maximum concentration of contamination is identified deep within the aquifer, then design the well screen and position the pump to collect samples from this region of the well; else install the screen and pump in the uppermost section of the unconfined aquifer. **PSQ 3**. If particle size distribution suggest groundwater flow into the well is not laminar, then adjust the depth of the pump; otherwise place the pump and screen in the area of maximum contamination.
	What are the consequences of making an incorrect decision and what is the tolerance for an incorrect decision? **PSQ 1**. If the data indicate soil moisture and chemistry contributes to casing corrosion, when in fact soil moisture and chemistry are not the cause of corrosion, then well life might be reduced and additional expenditures may be required to replace the corroded wells. **PSQ 2**. If the maximum concentration of contamination is identified deep within the aquifer, when in fact the maximum concentration is in the upper portion of the aquifer, then the pump will not be located properly and samples will not be representative of maximum concentrations and under represent risk. **PSQ 3**. If particle distribution suggests groundwater flow into the well is not laminar, when in fact groundwater flow in the well is laminar, then the pump will not be located properly and samples will not be representative of maximum concentrations and under represent risk.
Estimation Problem	Develop the specification of the estimator by combining the true value of the selected population parameter with the scale of estimation and other boundaries: • A statistical sampling design is not applicable to this effort; therefore, concentrations detected will only be compared to background levels, cleanup value or both for decision making. The sampling design is based on judgmental sampling.
	What are the acceptable limits on uncertainty? Limits of uncertainty are mainly associated with the dilution of groundwater during sampling and analytical laboratory error. Very low pumping rates during sampling and procedures minimizes uncertainties related to sample quality. The limits on analytical uncertainty shall be specified in the SAP. A robust quality assurance/quality control program minimizes analytical uncertainties.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

Plan for Obtaining the Data

(Specify the general plan of obtaining the needed data and explain where and how the information in this Planning Record will be formalized in a data collection plan)

Characterization data necessary to evaluate the PSQs identified in this DQO will be collected during the drilling of well 699-43-43B by sampling and analyzing vadose zone soils and groundwater. Soils and groundwater shall be collected and analyzed for anions, pH, inductively coupled plasma metals, tritium and iodine-129; geotechnical soil properties of interest includes only moisture content. In the field, continuous Radiological Control coverage shall be provided for health and safety and identify additional potential zone on contamination. Groundwater sampling within the scope of this plan will commence in 699-43-43B after well construction and well development, but before long-term groundwater commences. During groundwater sampling of the well, pH, oxidation reduction potential, dissolved oxygen, specific conductance temperature and turbidity will be measured. Sample collection will commence after field readings are stable. A low flow pump shall likely be used to collect samples from aquifer. Spectral gamma and neutron moisture geophysical logging and geologic logging is within the scope of activities planned. Additional detail has been documented in the SAP based on the decisions, action items, and key points of discussion from the July 2019 meeting with the DOE-RL, Ecology, CHPRC, WRPS, and INTERA.

Practical considerations to be accounted for during the planning of sample collection include:

1. Cultural and ecological site restrictions.
2. Not all soil and sediment samples may be collected as planned because of insufficient sample volumes.

The location of 216-B-3 Pond and groundwater monitoring well 699-43-43B are shown in Figure B-1.

Appendix A – Systematic Planning Record

Characterization Data Collection Planning Record

NOTE: In cases where the requested information is not applicable, state that, and explain why it is not applicable so that it is clear that a required field has not been forgotten.

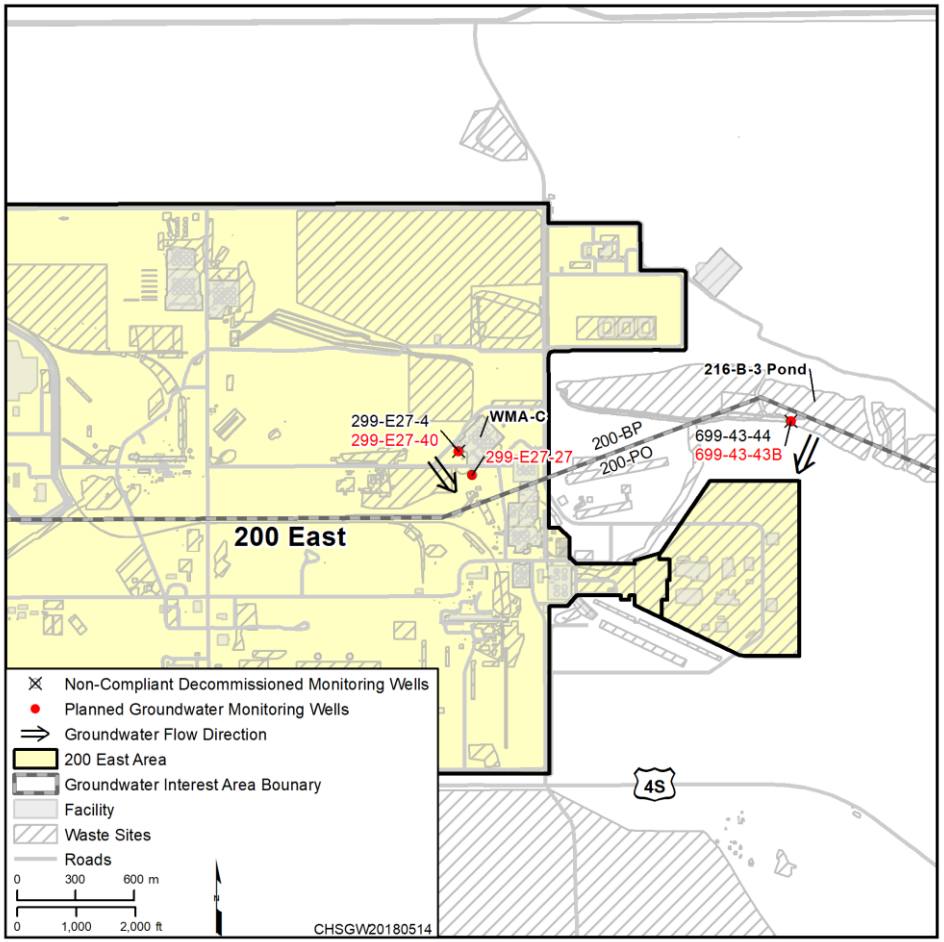


Figure B-1. Well Location Map

Note: Drilling locations may be subject to change pending the identified practical considerations.

Table B-1. Generic Sample Design for Groundwater Monitoring Well 699-43-43B

Sample Collection Method	Soil Sample Interval - Chemical Analysis[a]	Soil Sample Interval - Geotechnical Soil Properties Analysis - Moisture Content Only	Groundwater Samples[a]
Split spoon/pump[b]	10-12.5 12.5-15 25-27.5 30-32.5 32.5-35 35-37.5 37.5-40 70-72.5	10-12.5 12.5-15 25-27.5 30-32.5 32.5-35 35-37.5 37.5-40 70-72.5	187 191
Number of samples	8	8	2
Summary			
Number of split-spoon samples		8	
Number of water samples		2	
Approximate number of quality control samples		As specified in Table 2-4 of the Sampling and Analysis Plan in the main text of this document	

Note: Sample depths may be adjusted based on field conditions and the depth to water table. All depths are below ground surface in feet.

a. Anions, pH, inductively coupled plasma metals, iodine-129, tritium.

b. The primary sampling device in soils is the split spoon sampler with liners. A low flow or submersible pump shall be used to collect groundwater samples.

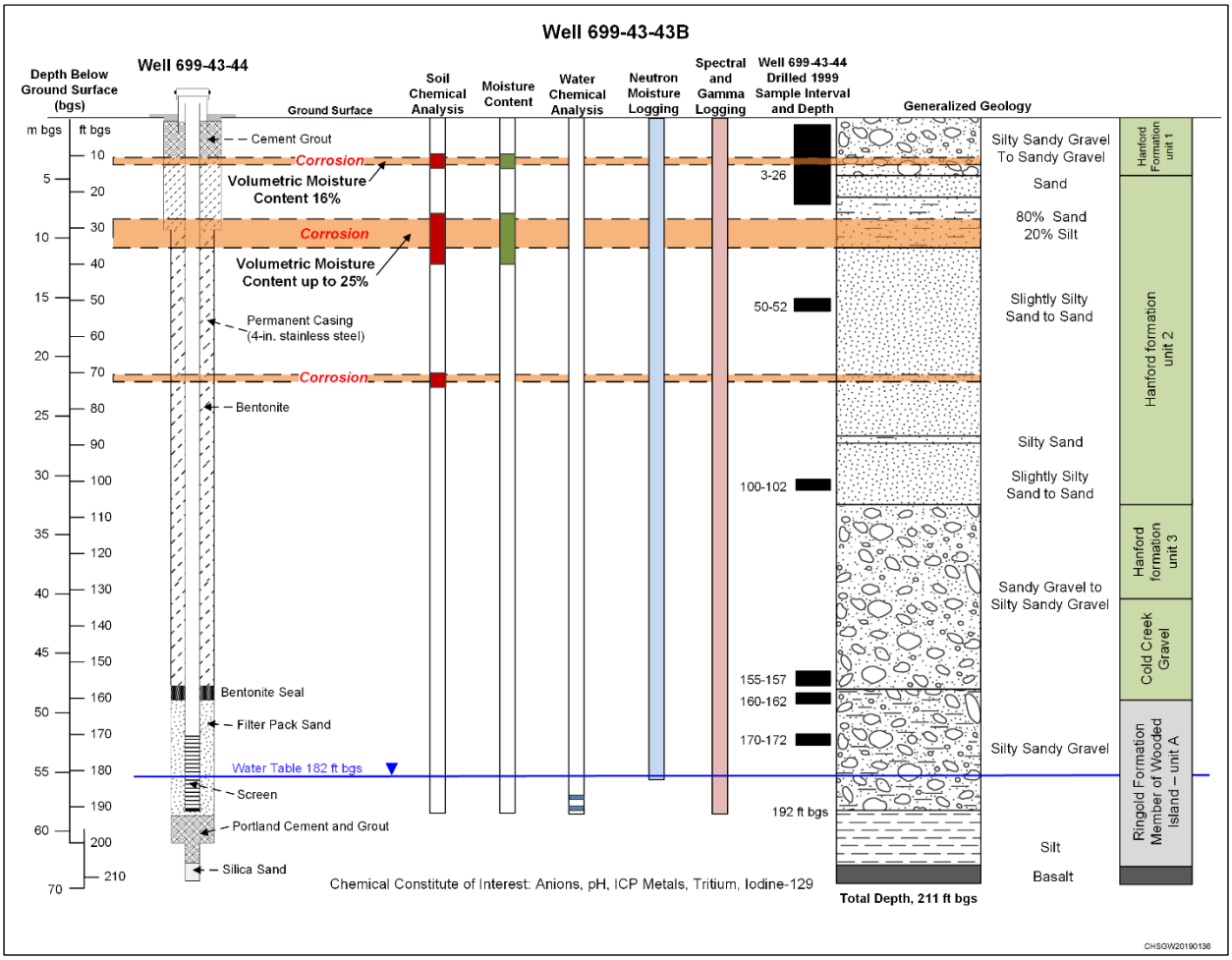


Figure B-2. Visual Presentation of 699-43-43B Sample Design

Table B-2. 216-B-3 Pond Well Analytical Methods

Nonradioactive Analytes	Analytical Methods*	Media		Sample Priority
pH				
pH	150.1	Soil	N/A	3
Anions				
Anions	300 or 9056	Soil	Water	1
Metals				
ICP-AES and ICP-MS metals (includes uranium)	6010 and 6020	Soil	Water	4

Table B-2. 216-B-3 Pond Well Analytical Methods

Nonradioactive Analytes	Analytical Methods*	Media		Sample Priority
Radionuclides				
Iodine -129	Low energy gamma or gas proportional counting	Soil	Water	6
Tritium	Liquid scintillation counter	Soil	Water	5
Geotechnical Soil Properties				
Gravimetric moisture content	ASTM D2216	Soil	N/A	2
Field Screening				
Radiological screening by radiological control technician	Continuous - Hanford Site procedure	Soil	N/A	Continuous
Dissolved oxygen	Field measurement instrument/meter	N/A	Water	N/A
Oxidation-reduction potential	Field measurement instrument/meter	N/A	Water	N/A
pH	Field measurement instrument/meter	N/A	Water	N/A
Specific conductivity	Field measurement instrument/meter	N/A	Water	N/A
Temperature	Field measurement instrument/meter	N/A	Water	N/A
Turbidity	Field measurement instrument/meter	N/A	Water	N/A
Spectral gamma logging	Contractor procedure	Soil	Water	After downsizing casing and at total depth
Neutron moisture logging	Contractor procedure	Soil	N/A	After downsizing casing and at total depth

References: ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/ Chemical Methods, Third Edition; Final Update VI*.

EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Waste*.

*For EPA Method 300.0, see EPA/600/R-93/100. For EPA Method 150.1, see EPA-600/4-79-020. For four-digit EPA methods, see SW-846.

EPA = U.S. Environmental Protection Agency

ICP-AES = inductively coupled plasma-atomic emission spectroscopy

ICP-MS = inductively coupled plasma-mass spectrometry

N/A = not applicable

pH = hydrogen ion concentration

B2 References

ASTM D2216, 2019, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30002U3P.txt.

EPA-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196019611.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Pub. L. 94-580, 90 Stat. 2795. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/hw-sw846.